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Index to Advertisers and Classified Index Following Reading Matter.

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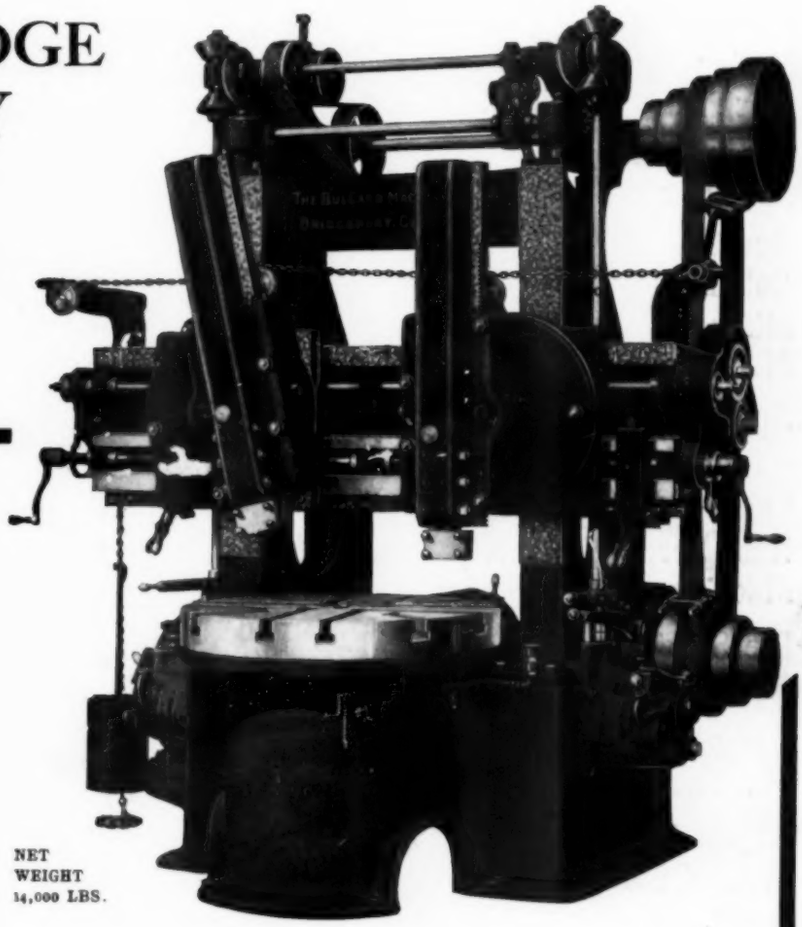

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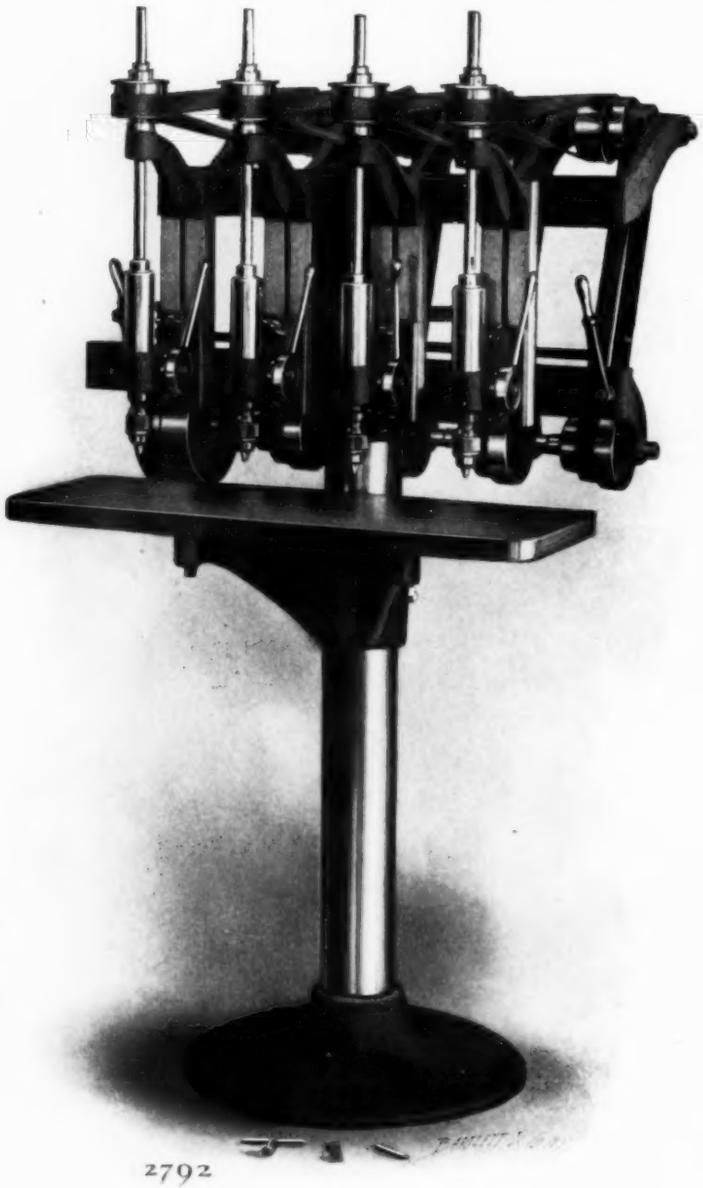

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Universal Joints for Automobiles

Analysis of the Hooke's Joint and Description of Various Types of Universal Couplings Used in Auto-car Construction

BY E. J. BARTLETT

Various forms of flexible couplings have long been used extensively in all forms of mechanical devices where power is to be transmitted through shafts which are not in line or are liable to disalinement. The application of the ordinary flexible couplings to automobile service, however, clearly demonstrated the fact that they were not entirely suited for the more severe duties encountered in this class of work; but, owing to the time and attention the designer found necessary to devote to the principal units, which were not so well understood then as now, the coupling and driving-shaft problem did not receive the attention it demanded.

A Problem Long Left Unsolved

Only too often there was a tendency to leave this important connection until the last and then arrange it in the cheapest and easiest way possible. It is therefore not strange that until recently the weakest point in the shaft-drive car has been in the shaft drive itself, as proved by the excessive wear and trouble frequently developing in these parts. As this form of drive has increased in popularity and its adaptation for many high-powered cars has followed its extensive use on low- and medium-powered cars, and as designers have found more time and attention to devote to the problem, owing to the development of the principal units of the car, many improved types of flexible couplings have made their appearance. There is as yet, however, little uniformity in design.

Location of Couplings

Fig. 1 shows diagrammatically the location of the principal flexible couplings employed in a typical example of the shaft-drive automobile of the gasolene type. There are, of course, many other similar couplings used for the driving shafts of the circulating pump, magneto, etc., but as they need not differ from standard designs they will not be mentioned further. In common practice there are three individual units to be connected. These are the power plant *A;* the change-gear device *B;* and the rear-axle mechanism *C*. The first two are mounted on a frame which for easy-riding qualities must be flexible to a degree, as exemplified by the modern pressed-steel frame.

Importance of Flexibility

To prevent binding and cramping in the bearings with a resulting loss of power, the connecting shaft must have interposed couplings of a more or less universal nature. Also, if a cone clutch is used to transmit the engine power, these couplings allow it to be centered at all times, thus increasing its efficiency. The importance of these couplings is secondary, however, to those in the propeller shaft *D*, as they are better protected, have much less angular variation and have less torque to transmit. With the exception of some simple couplings to be described later, we need not refer further to the connections between the engine and change-gear device, as the discussion and descriptions of joints suitable for the propeller shaft will also apply in a less degree here.

Conditions to Be Fulfilled

Considering then the propeller shaft only, we find a number of conditions or combinations of conditions which the couplings must fulfil: First, they must transmit a variable torque which is at times high and in the form of shocks, as when the brakes are suddenly applied on the rear wheels and the momentum of the revolving parts in the change-gear mechanism is to be overcome; or when the clutch is suddenly put in and the inertia of the rear wheels and their driving mechanism is encountered. Second, they must be designed to work through a considerable variable angle, owing to the jounce, rebound and lateral movement of the springs. There must also be some provision for a change in length of the propeller shaft as the change-gear mechanism changes its vertical hight with the movement of the springs when traveling over rough roads. Third, the size of the parts must be determined with a view to keeping the car weight and inertia and momentum factors as low as possible.

Owing to their exposed location it is very difficult, in some forms, to provide sufficient protection for the bearing surfaces against dirt; and there is also to be considered the difficulty in providing adequate lubrication for the wearing surfaces.

General Forms and Principles

What are said to be the two oldest forms of flexible couplings were invented during the seventeenth century by two Englishmen and named for their inventors. They are the Oldham coupling and the Hooke's joint, ordinarily called the universal joint. These two forms have been greatly modified in the many types of joints and couplings which have since appeared, and in some cases have practically lost their identity.

The Oldham coupling is much less used for automobile work such as we are considering than is some form of the universal joint. It is applicable only to the connecting of shafts which are parallel and but a little distance apart, such as the connections from the engine to the change-gear box; or, in the case of a double-chain driven car, they are frequently used in the countershafts extending from the change-gear box to the outside of the frame in line with the rear driving sprockets.

The Oldham Type

A typical form is shown in Fig. 2. It consists of three parts. Two of these may be alike, having hubs with circular flanges fastened to the adjacent ends of the shafts to be connected. Diametrically across the faces of these two flanges are milled grooves as shown, and the two members are assembled with the grooves at right angles to each other. The third member is a disk of the same diameter as the flanges, and on the opposite sides are two diametral tongues usually made integral with the disk and formed at right angles. These tongues are a sliding fit in the grooves in the flanges. As the bearing surface near the center is of little benefit, a cavity may be formed as a receptacle for hard grease, with which it may be packed, or supplied from a grease cup mounted on one of the hubs. The heat generated by friction will melt minute portions of the grease, which, by centrifugal force, will be forced outward on the rubbing surfaces. The materials used in construction may be a steel center member with hard bronze disks; or all three members may be of steel, case-hardened, care being taken in the latter case not to make the sections so thin that warped surfaces will result.

The Hooke's Joint

Fig. 3 shows in diagram form the simple universal joint. The shafts *A* and *B* to be connected have forked ends secured to the four arms of the center cross *C*, which are at right angles to one another. The ends of the arms of the cross in the same line are thus pivoted about the axis through the other arms.

A little study of the diagram will show that the motion transmitted by a joint of this kind is not uniform, as the angular velocities of the shafts are unequal. All good books on mechanics treating of the

Hooke's joint demonstrate this mathematically, and also that during one revolution the speed of the driven shaft varies twice between an angular velocity that is greater and one that is less than that of the driving shaft; also that between these limits there are four positions where the angular velocities of the two shafts are the same.

The Amount of Variation

The amount of this variation depends on the angle at which the shafts work, considering them in the same vertical plane and parallel in the horizontal plane, as shown in Fig. 3, the angle being designated as *a*. Assuming the driving shaft to have a uniform motion, then the lowest speed of the driven shaft will be equal to the speed of the driving shaft multiplied by the cosine of the angle between them, above referred to; and the greatest speed of the driven shaft will be equal to the speed of the driving shaft divided by the cosine of this angle.

To show that this variation is of practical importance let us assume as a concrete example a driving shaft with a speed of 1000 revolutions per minute working through an angle of 15 degrees. The least speed of the driven shaft will then momentarily be $1000 \times \cos. 15 \text{ degrees} = 1000 \times 0.966 = 966$ revolutions per minute, and the greatest speed will be $1000 \div \cos. 15 \text{ degrees} = 1000 \div 0.966 = 1035$ revolutions per minute, in round numbers. The maximum variation will then be $1035 - 966 = 69$ revolutions per minute, or 6.9 per cent., which is quite an item, although of course the angle assumed would normally be encountered only on the recoil of the springs.

Neutralizing the Irregularity

Fig. 4 is a diagram showing double universal joints by means of which the irregularity in the motion, with the resulting wear imposed on the parts, is avoided or, rather, neutralized. It is essential that the two intermediate forks be mounted in the same plane as shown, for then a uniform motion of the driving shaft will produce motion not uniform in the intermediate shaft, which in turn imparts a uniform motion to the driven shaft. The angular velocities will also be uniform if the angles *a* and *b* are equal, the shafts being in the same plane.

Single or Double Joints

In connection with the action of the single- and double-joint construction it may be said that designers are not entirely agreed as to the number of joints to use for the shaft-drive automobile. The single joint certainly has its simplicity to recommend it and is used by several manufacturers with success in connection with an inclosing tube, which acts as a rear-axle strut or torsion bar, as shown in Fig. 5. This construction also affords better alinement of the rear-axle driving pinion, owing to the increased distance between its bearings. The inclosing strut tube affords protection against dust and dirt and gives improved lubricating facilities.

Separate Provision for Shocks

On the other hand it must be remembered that the usual forms of universal joints are fundamentally torque-transmitting devices and make little, if any, provision for the heavy shocks which must be taken on the joint if this construction is used. How serious the results of these shocks are depends largely on the type of joint and its support. The majority of cars of the shaft-drive type on the market are equipped with double joints, thus providing for the relative movement of the parts connected, and have provided separate devices for taking the road shocks encountered, thus following out the idea of one device for one purpose, which still remains popular in the automobile world.

Surrounding Conditions

To maintain the same degree of durability and smoothness of operation in the propeller-shaft parts as in the other important units of this car it is necessary to look farther than the shaft itself. Many of the ills encountered in this torque-transmitting device might easily be avoided by giving more attention to the surrounding parts. The value of proper shock-resisting construction has already been touched upon, and to this may be added the importance of a small angle through which the joints are required to operate. Making this angle as near zero as possible under normal loaded conditions will decrease the destructive end thrust and allow a very simple telescopic joint to be used.

Square-section Slip Joint

Where the normal angle is 5 degrees or less the ordinary squared-section slip joint shown in Fig. 6 gives good satisfaction when lubricated, which can be easily done by mounting a grease cup on the hub and providing proper distributing grooves in the male member.

In some cases the normal angle is considerably more than 5 degrees. With such an extensive angle, which should be avoided where possible, the squared shaft may grip its hub if the recoil of the springs produces a great angle at the instant of great torsional strain. Some designers prefer shafts of other sections than square, such as include, for instance, feathers milled integral with the shaft, but the results with an excessive angle are much the same.

General Types of Joints

For convenience universal joints may be divided into three general classes based on the form of the connecting member. These, in the order of their adoption and general use for automobile purposes, are the cross, the ring, and the ball joint.

From what has preceded we may summarize the important points to keep in mind in considering these different types and their modications, as follows:

1. Minimum cost and number of parts consistent with satisfactory construction.
2. Sufficient strength with a large factor of safety to transmit the maximum torque of the motor.
3. Sufficient bearing surfaces to insure long life and provision for end thrust.
4. Adequate lubrication and protection against dirt to insure durability.
5. Suitable adjustment for, or provision against, excessive wear.
6. Minimum weight consistent with strength.

The Cross Type

Broadly speaking, the cross type, as its name implies, consists of a cross-shaped center member the extremities of the arms of which are the pivots carried in and connecting the forked ends of the shafts. Its chief advantage is its simplicity and the ease with which the bearing surfaces may be carried sufficiently far from the center to keep the bearing pressure within practical limits without undue weight. On the other hand it lends itself poorly to the protection of the bearing surfaces against dirt, and affords little opportunity for carrying a lubricant in any quantity at the center so it may be fed to the bearings by centrifugal force.

Simple Joints

One of the simplest of this class of joints and one which is used with satisfaction on several different cars is shown in Fig. 7. The pivot pins are offset to allow them to pass by each other, which is not theoretically correct, as a slight lack of uniformity in the motion occurs; but the results are not serious in practice. All bearing surfaces are of hardened steel and lubrication is provided for by mounting a cold grease cup on the cross. The grease works outward in the grooves in the pins as the shafts revolve.

Fig. 8 shows a joint the pivots of which are made integral with the cross and in the same plane, necessitating capped bearings in the forks. The flanges on the inside of the cross act as a reservoir for a thick oil which feeds through small oil holes in the pivots to the hardened-steel bearings.

More Elaborate Designs

Another more elaborate cross joint is shown in Fig. 9. The steel center member is hollow and filled with oil-saturated felt, the supply of oil being renewed through the oiling screw hole in one of the steel trunnions. These trunnions are screwed and pinned in the forks. The cross is centered and adjusted for wear by means of the check nuts screwed on its arms.

Another form is shown in Fig. 10, in which bushings are clamped and locked

by detent pins in the forks. The cross and pivots are in one piece, the center being hollow and filled with oil. The general construction is apparent from the sketch.

A Joint with Numerous Parts

The form of joint illustrated in Fig. 11 consists of some thirty pieces all told. The arms of the cross are in the same plane and are built up by inserting the pivot pins in a steel center block at right angles. One of the pins is large in the central portion, allowing the other pin to pass through it. The smaller pin is in turn held in place by a small rod. Steel bushings are inserted in the forks and threaded on the outer ends for grease cups locked by springs. The hollow ends of the pivot pins and the grease cups hold sufficient grease to last a long time, so that for ordinary running the joint may be packed with grease and used the entire season with no further inspection. Felt washers prevent the grease from working out, and small holes and grooves convey it to the bearing surfaces.

A Type Extensively Used

One of the first joints to be developed expressly for automobile service and extensively used at present is seen in Fig. 12. It is a modified form of the cross type, in which the center cross and arms

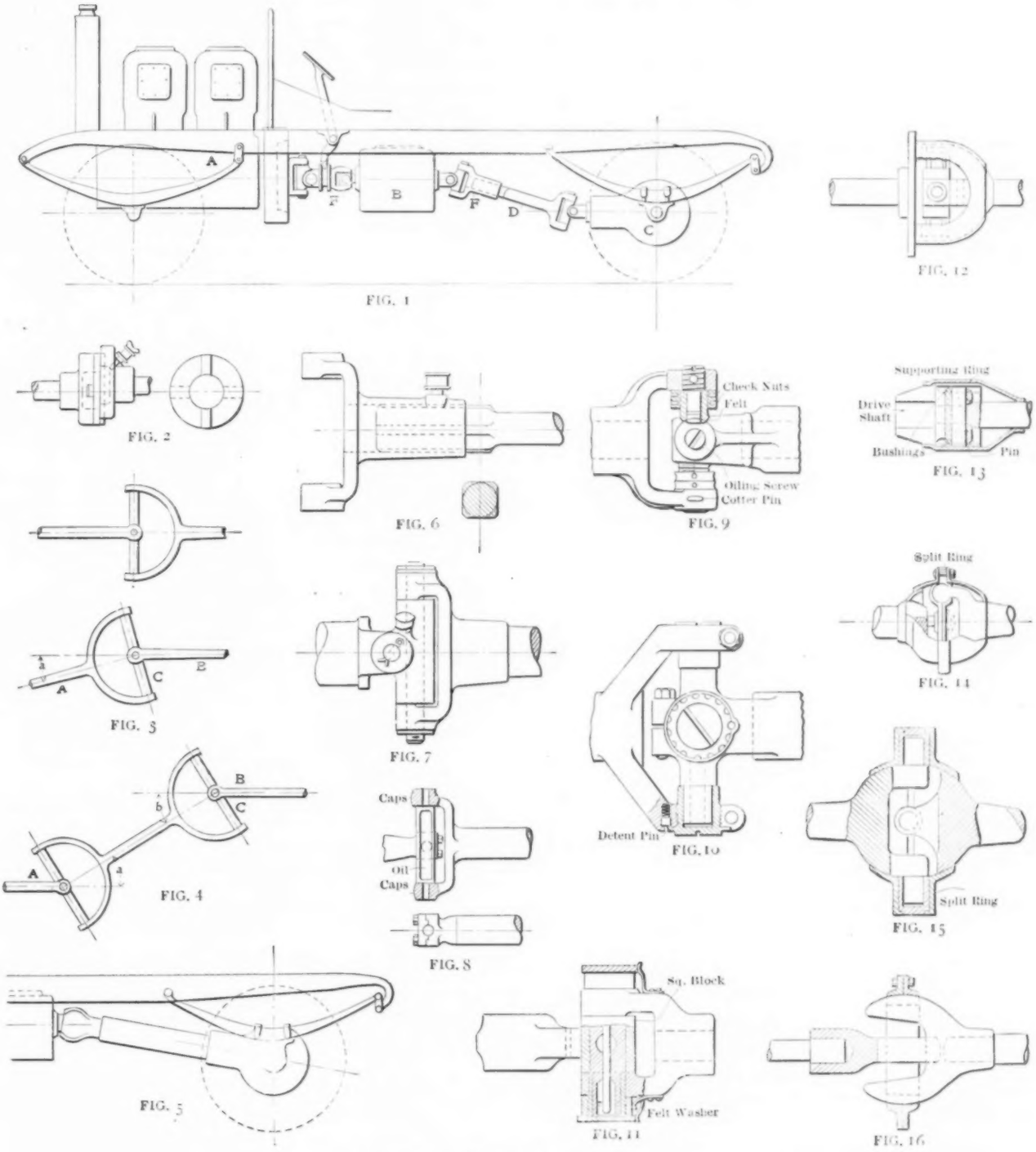


FIG. 1 FIG. 12 FIG. 2 FIG. 6 FIG. 9 FIG. 13 FIG. 3 FIG. 7 FIG. 10 FIG. 14 FIG. 4 FIG. 8 FIG. 15 FIG. 5 FIG. 11 FIG. 16

UNIVERSAL JOINTS FOR AUTOMOBILES

are integral. The forks are slotted out just enough to allow the pivots to enter. They are retained by small renewable bronze bushings slipped over them and fitting holes in the forks. These bushings are in turn held in place by a pressed-steel cover inclosing and protecting the entire joint. This cover affords an excellent reservoir for a lubricant. This joint would seem to conform very closely to all the requirements of this class of work.

Combination Slip and Universal Joint

A form of joint which combines the slip-joint and universal-joint action is shown in Fig. 13, and has proved very successful in practice. It consists of a cup-shaped end on the driving shaft, slotted on opposite sides lengthwise of the shell. The driven shaft terminates in a ball-shaped end, fitting the interior of this shell. Through the ball is passed a short pin, which projects into the slots in the shell. Hardened blocks are mounted on the ends of this pivot pin to increase the bearing surface. It is seen that if the slots are of sufficient length the joint is telescopic to a degree sufficient to allow for the necessary change of length of the propeller shaft as the springs deflect and recoil.

Enough examples of the cross type of joint have been shown to give a pretty fair idea of how they meet the requirements of automobile service.

The Fork and Ring Design

The second class of joints, those of the fork and ring type, from the nature of their construction lend themselves more readily to protection and lubrication, and in general they are simpler and more symmetrical in appearance.

One of the more recent joints of this type which has been developed for automobile service is shown in Fig. 14. It is an application of the well known ball and socket joint, in which the balls are the ends of the forks carried on the shafts and the sockets are formed in a two-piece annular ring. These spherical sockets are slotted to allow movement of the balls due to the angular motion of the shafts. A metal case provides protection against dirt and forms a receptacle for a lubricant. The idea of the annular ball bearing has been carried out, inasmuch as no adjustment for wear is provided, as it is practically eliminated by the hardened bearing surfaces. As this surface is nearly equal in all planes this construction is especially adapted to take side and end thrust as well as torque.

Other Forms of the Ring Class

Fig. 15 illustrates a joint which has its pivots integral with the forks. Over these cylindrical pivots are placed bushings which are held by a split ring with its inner contour spherical. The forks themselves are wide and of spherical shape, to suit the connecting ring. This construction, while somewhat expensive, affords good protection to the bearing surfaces and permits of a considerable quantity of lubricant being carried at the center.

Another ring joint which is rather unique is shown in Fig. 16. The outline of the forks is in part circular, and they are held together by a split ring, the inside of which is slotted to form bearings for the forks. The general construction is shown in the sketch.

Several other forms of this type of joint are also in use, such as a one-piece ring into which are screwed four trunnions, whose inner ends are tapered and fitted into tapered holes in the forks inside the ring. Enough forms have been mentioned, however, to give an idea of the application of the ring type.

Ball Joints

The third, or ball, type is comparatively a newcomer for automobile work where considerable strain is encountered, and as yet has been developed mostly along the lines of the small ball joint familiar to everyone. Its principal advantage lies in its externally symmetrical appearance and consequent ease of protection and lubrication. For light work it is small for a given strength and has large bearing surfaces, but it is not unlikely that its somewhat excessive weight when made of sufficient size to stand the strain of the propeller shaft will prevent its becoming very popular for this service.

A Simple Cam-milling Device

The job was to mill a lot of cams similar to *A*, Fig. 1, about 3 inches in diameter and 3/16 inch thick. Every shop but one in the neighborhood turned it down because the head end of the comma was so nearly radial—the one that would tackle it wanted $1 apiece, 50 cents a slot.

So instead of letting the job out to a regular cam-cutting establishment, it was up to the shop building the whole machine to cut the cams. The milling machine was busy, so were all the rest of the tools except an old lathe in the corner.

A hand wheel *W* with a large hub was made, said hub running through a bearing block *H* and having a disk *C* on the other end which was bored for the cams as shown. The holder *H* is bolted to the tool slide, the screw removed, and the carriage controlled by a wire fastened to the back, running over a common grooved pulley with a screw shank, held in a block of wood, which, together with other blocks to bring it up to the desired hight, is held to the lathe board by a *C* clamp. The bucket *X* contains a choice collection of scrap iron to hold the carriage against the guide or master cam, cut in the hub of the wheel as shown at *M*, Fig. 1, and in the end view of Fig. 2.

The guide pin *G* is of hardened steel, fitting in the tail spindle. This goes into the master cam, and as the wheel is turned the carriage slide *S* moves so as to produce the same cam in the work at the other end of the hub. In operation, the guide pin is set at the outer end of one of the slots, the piece to be milled is put in the holder *C*, in a similar position and clamped with a small C clamp so as to leave one slot clear. The guide *G* forces the whole thing toward the milling cutter *B*, and starts the cut at about one-third the thickness of the plate, which is all such a cutter could carry. Three cuts finished the slot, then a clamp was put on the other side over the finished slot, and the second cut milled in the same way.

And it didn't cost $1 apiece either, in spite of the makeshift clamping device.

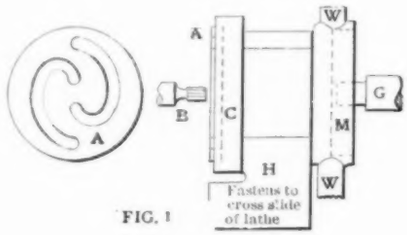


FIG. 1

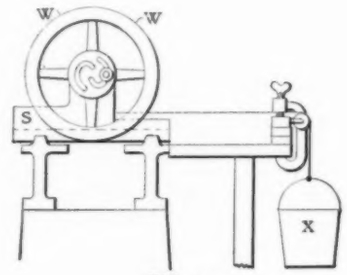


FIG. 2

SIMPLE CAM-MILLING ATTACHMENT

In fact a plain, ordinary boy could mill four to five an hour and not endanger the palpitations of his heart.

A modification of this idea can be used for milling surface cams as well as other forms of face or disk cams.

According to the *Brass World* a new method of toughening metals has recently been brought out which is quite novel. The metal to be treated is placed in a closed retort and a small quantity of mercury placed in it. The retort is now subjected to pressure and then heated below the melting point of the metal. While the heating is going on, a current of electricity is passed through the metal. It is said that metal treated in this manner is greatly increased in toughness and in ability to withstand the effect of sea-water and other corrosive agents. While more particularly adapted for treating iron and steel, it is said to act in the same manner on other metals.

Laying Out and Machining Elliptical Gears

On several occasions I have found it convenient to make use of elliptical gears in making alterations in special machinery, and in designing new machines. As I have seen very little written on this subject, some of my experience in the construction of single-lobe gears may be of interest, and lead others to criticize or suggest better methods.

The Conditions To Be Met

In Fig. 1 the shafts *C* and *D* revolve at the same number of revolutions per min ute or average speed, but it is required that *D*, the driven shaft, shall have an irregular motion. At a certain point in its revolution, its speed must equal twice the speed of *C*. The use of elliptical gears of equal size appears to be the simplest means of accomplishing this result.

Fig. 1 is a diagram showing the shafts and the ellipses representing the pitch lines of gears, and giving the dimensions. To determine the shape of the ellipse it is first necessary to locate the shaft centers relative to the geometrical center of the gears. In gears of this class, the major axis of the elliptical pitch line is equal to the distance between the shaft centers, which in this case is 1⅞ inches. The proportion between the shortest distance from the shaft center to the pitch line, and the greatest distance from the shaft center to the pitch line must in this instance be 1 to 2. Then $\frac{1\frac{7}{8}}{3} = \frac{5}{8}$ inch for the shortest distance, and $\frac{1\frac{7}{8} \times 2}{3} = 1\frac{1}{4}$ inches for the greatest distance. This brings the shaft center 5/16 inch from the geometrical center. If we revolve *A*, Fig. 1, on the arc *f g* (the radius of which is equal to the shaft center distance) 90 degrees around *B* to a position shown at *A'*, we have the gears with their small diameters in contact. Joining the shaft centers by the line *h i* and the geometrical centers by the line *j k*, we form two right-angled triangles. It will be seen that *h i* cuts *j k* at *l*, the point of contact on minor axis. On triangle *h k l* we have two dimensions given: 5/16, the base, and 15/16 (one-half center distance of the shafts) for the hypotenuse. Altitude equals

$$\sqrt{(\tfrac{15}{16})^2 - (\tfrac{5}{16})^2} = 0.883 \text{ inch.}$$

The minor axis of the ellipse is $2 \times 0.883 = 1.766$ inches.

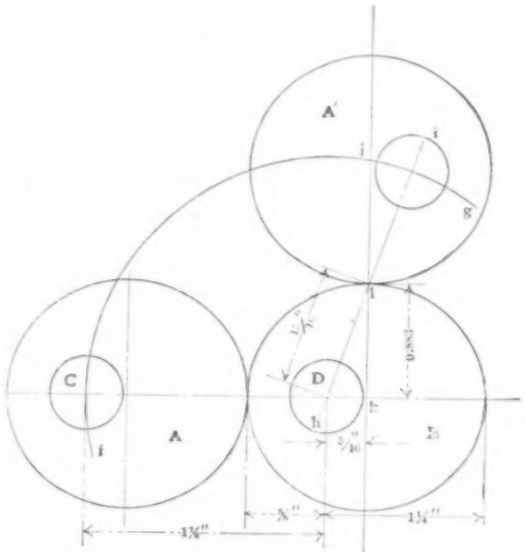


FIG. 1 The Elliptical Pitch Lines

Approximating the Ellipse by Four Circular Arcs

Constructing an ellipse whose major axis is 1.875 inches and minor axis 1.766 inches, it is found that four centers may be selected from which arcs may be struck that will closely approximate this ellipse. Fig. 2 shows the position of these centers and also the radii of the arcs, with 0.0625 inch added for the outside radius of the 16-pitch gears.

An ellipse of this size will contain slightly more than twenty-nine 16-pitch teeth. However, with 29 teeth there will be an error of only about 0.001 inch in the thickness of each tooth. The gears are to be made of machine steel and have a hub projection of ½ inch on one side.

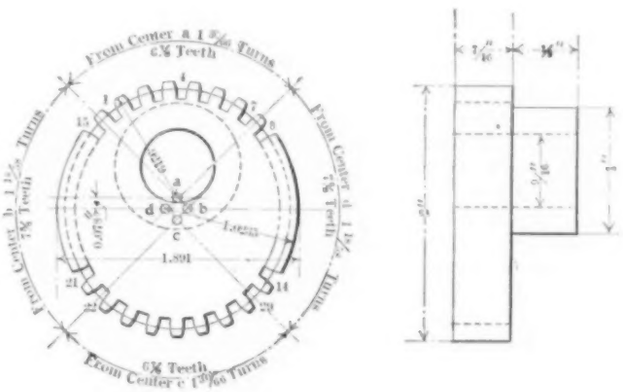


FIG. 2 The Gears formed by four Circular Arcs.

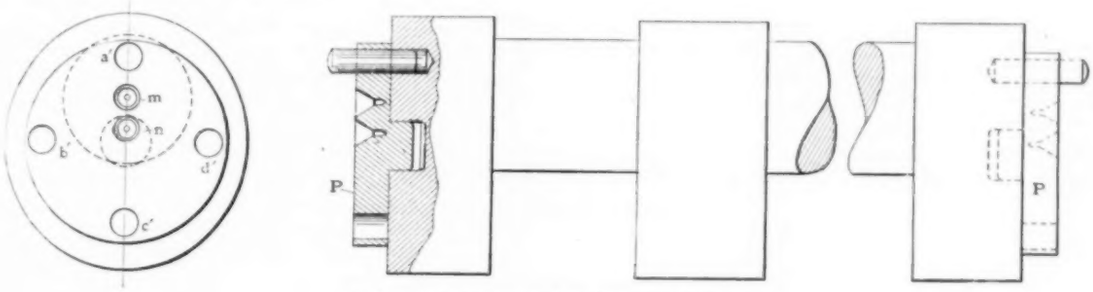


FIG. 3 The Bar from which the Gears are to be cut Arranged for Mounting on Centers

How the Gears are Constructed

We form and cut the gears on a bar of steel and afterward cut them off. A bar of sufficient length to make the required number of gears, or as long as may be conveniently handled, is centered, faced on the ends, and turned to nearly the size of the gears across their largest diameter; and a ⅜-inch hole is bored in each end for the hubs of the plates *P* shown in Fig. 3. These plates each have a 60-degree center *n* 0.078 eccentric to their hubs and an-

other 60-degree center *m* 5/16-inch eccentric to their hubs. They also have four index holes spaced 90 degrees, as shown. Passing across the face of the plate and cutting both 60-degree centers is a line which at one end is extended across the perimeter. The bar from which the gears are to be made, after being turned all over, is set in V blocks on a surface plate, and with a scriber set to the hight of its center a line is scribed across each end of the bar, one parallel to the other. The plates *P* are then placed on the end of the bar with their hubs fitting the 3/8-inch holes already bored, and set with their center lines matching the lines on the end of the bar. A hole is drilled and reamed in each end of the bar for an index plug, the holes *a'* in *P* being used as a jig.

The Lathe Work

An index plug is fitted in place and the whole mounted on centers *m* in the lathe. As centers *m* are 5/16 inch eccentric, they correspond to the shaft centers of the gears. While on these centers, the bar is necked down for the hubs. The plates *P* are next turned 90 degrees and the index plug is placed in the hole *b'*. This brings the center *n* to correspond with *b* Fig. 2, from which the 1.0235-inch arc is struck. With the tool set 1.0235 inches from the lathe center, one of the arcs is turned. Revolving plates *P* 180 degrees and inserting the index plug in hole *d'*, the opposite arc is turned without disturbing the setting of the tool.

The Milling Work

The 0.9219-inch arcs are preferably formed on a milling machine with an end mill by revolving the blanks on the milling-machine centers. These arcs cannot readily be turned in the lathe, as other parts of the blank would interfere with the tool. For the arc from the center *a*, Fig. 2, the plates *P*, Fig. 3, are turned so that the index plug will be in the hole *a'*, and for the arc from *c* as a center the index plug is in *c'*.

Cutting the Teeth

In cutting the teeth it is necessary to use different indexing for the different radii. For instance: a circle whose radius is 0.8594 inch will contain.

$$\frac{0.8594 \times 2}{0.0625} = 27.5$$

16-pitch teeth. To cut 27.5 teeth using a standard dividing head having 40 teeth in the worm wheel, we have $\frac{40}{27.5} = 1\frac{5}{11}$, or $1\frac{20}{44}$ turns for each tooth. There are two 90-degree arcs with a pitch radius of 0.8594. Both the arcs contain one-half of $27.5 = 13.75$ teeth. As there are 29 teeth in the gear, the two 0.961 arcs of 90 degrees each must contain $29 - 13.75 = 15.25$ teeth. A complete circle would contain 30.5. To divide a circle into 30.5 parts with a 40-tooth worm requires 1 19/61 turns of the worm. Most milling machines are not supplied with an index plate having 61 or a multiple of 61 holes, so we must select some combination that will closely approximate this, or resort to compound indexing. By using the 58-hole circle and moving the handle 1 turn and 18 holes, we get close results, especially as we cut only 8 teeth before resetting.

Locating the index centers central under the cutter, the blanks with plates *P* in position so that *n*, Fig. 3, corresponds with *a*, Fig. 2—that is, with the index plug in hole *a'*—the first cut (marked 4 in Fig. 2) is started on the center line. We only nick this first space and then back up three teeth to space marked 1. The other six spaces on this arc are indexed 1 turn and 30 holes in the 66 circle, and cut as usual. The cutter is set for depth from the outside in the regular way. Plates *P* are next moved so that the index plug comes in *d'*, and spaces from No. 8 to No. 14 are cut, first locating the cutter from space 7 and spacing 1 turn and 18 holes in the 58 circle. With the index plug in *b'*, the spaces from No. 15 to No. 21 are cut in the same manner. The spaces in the final arc are cut with the index plug in *c'* spacing 1 turn and 30 holes in the 66 circle. The cutter may be started from either space No. 14 or No. 21.

Completing the Job

The cutting of the teeth being completed, the bar is held in the milling-machine vise and the gears are sawed off. They are next taken to the screw machine, where they are drilled, bored and reamed, the gear being held by its hub in a spring chuck. Facing the sides and ends of the hubs on an arbor finishes the gear.

I have made several different sizes and proportions of this class of gears, using the method described, with very satisfactory results both in regard to cost and operation.

M. B. F.

Practical Use of the Microscope in Testing Material

At a recent meeting of the New York alumni of the Worcester Polytechnic Institute, Dr. William Campbell, of Columbia University, showed how a good microscope, with means of reflecting light on top of the specimen, was all the apparatus required for testing metals. The preparation of the specimen simply means the use of fine emery and rouge to obtain a high polish. Etching with acid sometimes gives better results, but is not often necessary.

With lantern slides he showed the difference in the qualities of iron and steel by this method and how the microscope will detect the effects of overheating, the varying of proportions in mixing and give a direct clue to the physical properties. A specimen from a chilled car wheel showed very clearly where the hard, chilled surface merged into the softer gray-iron backing or center of the wheel.

Placing the Blame

An instance of the practical application was cited where a large tank had collapsed and killed several workmen. The maker of the plates and the party who erected them each blamed the other, the rolling-mill people claiming the plates were of the best steel. Microscopic tests showed large streaks of slag, proving it to be iron instead of steel, and poor iron at that.

In another case Dr. Campbell tested blades of one of the numerous safety razors now on the market and found they varied greatly, that some gave excellent results, others very poor, and that in each case the fault lay in the treatment of the steel in hardening and that this fault could be detected very much better by the microscopic examination of the polished surface than by fracture.

The testing of steel, however, should be done after it has reached the stage at which you use it, instead of when it comes from the rolling mills. The tests should be made after heating, forging and machining, as these change its structure and affect the value of the material.

Erecting Large Engines Rapidly

Two of the four Allis-Chalmers engines for the Edgar Thompson works, Pittsburg, Penn., of the Carnegie Steel Company, were recently installed in record time. These are very heavy engines, with cylinders 50 and 78 inches in diameter by 60-inch stroke, the frame and slide being cast in one piece weighing 104 tons.

The old engine had to be torn out before installing the new one and three shifts of men were put to work to reduce the delay as much as possible, and within ten days it was ready for business.

As soon as this was completed steam was turned on and inside of thirty minutes steel rails were being rolled up to the full capacity of the engine. Two of these units are now in use at this plant, and have never been stopped except on Sundays from 7 a.m. to 5 p.m.

Two others of the same type are to be installed at the Homestead plant. These are tandem engines, with the low-pressure cylinder next to the frame and enough space between cylinders to allow a cross-head or slide to carry the weight of the piston rods. They average to run 75 turns per minute, are non-condensing with steam at 150 pounds pressure, and develop from 5000 to 8000 horse-power.

Wire ropes seem to belong to elevators and derrick rigging and it is something of a surprise to learn that some of the Gloucester cod-fishing schooners have been using them for rigging for over fifteen years.

A Few Tools from a Boring Machine Shop

Some of the Interesting Devices and Methods in Use at the Shops of the Binsse Machine Company, Newark, N. J.

EDITORIAL CORRESPONDENCE

The shop of the Binsse Machine Company, Harrison, N. J., has many interesting kinks in the way of special tools and devices for handling duplicate work, many, if not most, being due to the ingenuity of the superintendent, Mr. Benson.

High-speed steel, mostly the Heller brand, is used and high cutting speeds are the rule. The cost of high-speed steel makes it necessary to use it for cutting edges only, or as nearly this as possible.

Fig. 1 shows how a small piece is used as a reamer on a machine-steel bar, and the way in which it is fastened. The cutter itself is shown in section at *A*, and is threaded to fit the bar. It is fastened by the collar *B*, which must be behind the cutter and out of the way. There is a slot across the back of the cutter into which the projections *C* fit, and the sides of *B* are flattened for a wrench. The cutter and collar are screwed down together, being held by *C*, and the wrench on *B* gives just as good a means of tightening it as though it was a threaded nut ahead of the cutter. This same idea ought to fit in numerous other cases.

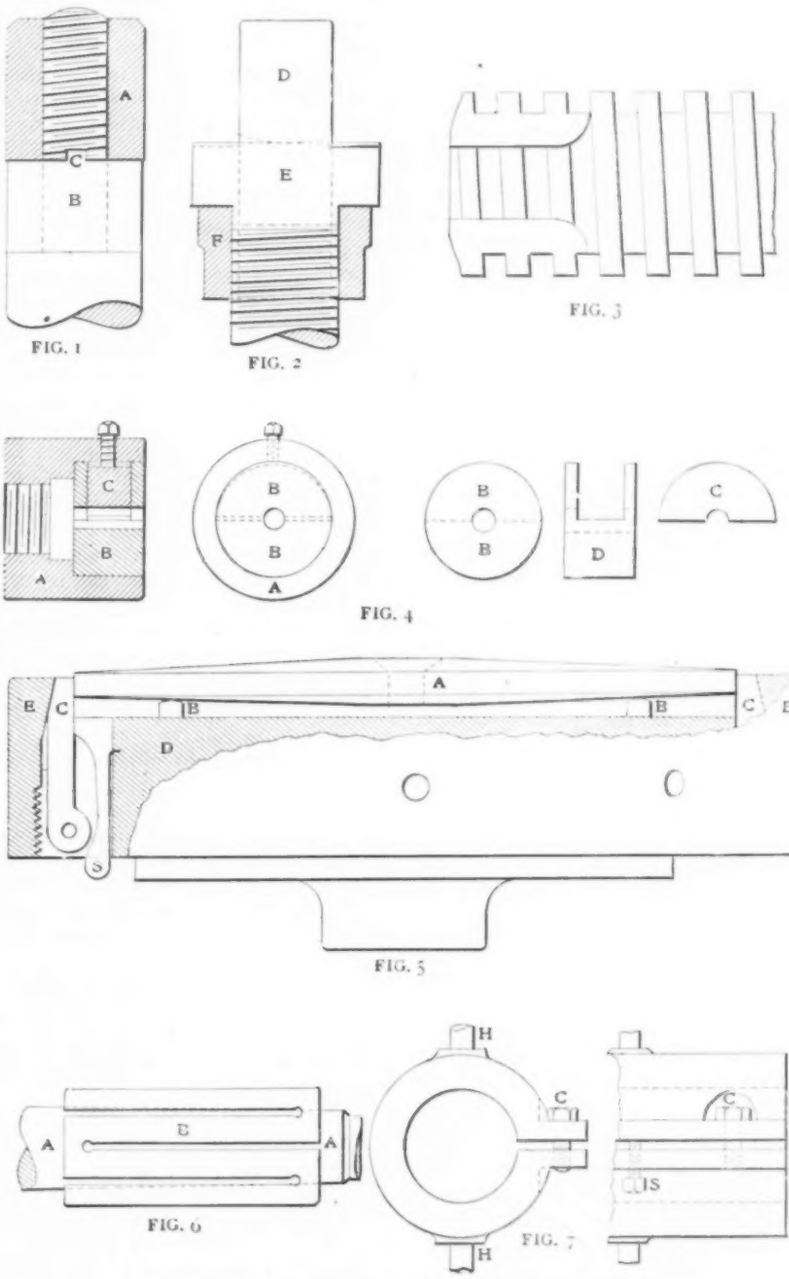
Centering Inserted Cutters

Boring bars with inserted cutters are common in all shops, but the manner of centering and fastening is varied to suit the taste. In this case the nut not only holds the cutter, but centers it as well. The nut *F*, Fig. 2, is recessed as shown and the cutter has a projection which just fits into this, as shown. The front end of the slot is filed a trifle rounding, not as much as shown, so as to give a three-point bearing, one each side of the nut and the third in the center of the bar. The cutter is just slipped into the slot, the nut centering and holding it to its work.

Tapping Long Holes

Although we ought to harden taps a foot long without any sign of springing and with no change in pitch, we do not always do it, even with the best of apparatus; and they sometimes go crooked and go long or short on pitch, as the case may be. To get over the effect of these difficulties on the work, they make the first tap with the threads a little "thin" or narrow to allow for cleaning out to size and to proper pitch with the finishing tap. This tap is made as shown in Fig. 3, with a full sized thread, but is milled only on the end for perhaps two inches. It is hardened only on the end for about an inch.

This avoids all springing and the variation in the pitch. The front end cuts out the threads to size, and the solid thread, back of the milled end, guides by completely filling the thread and insuring the correct pitch, as the finishing tap has not been affected by the heating and hardening process. It seems as though this would be hard to use on account of friction, but it is used successfully on all their square thread work with good results. The same idea can be applied to any other shaped thread as well as to this.



SPECIAL TOOLS FROM THE BINSSE MACHINE COMPANY

Chucks for Finished Work

Most shops have their own particular plan for holding finished work, but other

ways are always interesting as they may have advantages in some cases. A simple and efficient device is illustrated in Fig. 4. The body *A* fits the nose of the lathe spindle, and the bushing *B* is a sliding fit in the body. The upper half of *B* has a wide slot planed or milled across it, leaving a light wall at each end of *B*. This is shown in the section of the complete chuck with the piece *C* in this slot and in *D*. The piece *C* is loose and fits in this slot in *B*. After putting a liner in between *C* and the bottom of the slot, they are both clamped in the case for boring. Then the central hole is bored to the desired size, and will hold any finished work firmly without the possibility of marking it in any way.

Chuck for Grinding Disks

Friction disks are used for the feeding mechanism and these are finished by grinding. They have beveled sides, as shown by *A* in Fig. 5. The chuck fits the grinding machine, and supports the disk on hardened pins *B*, which are ground in position.

The jaws *C* are hinged in the body *D* and normally held out by the springs *S*. They are forced on to the work by the coned ring *E*, which has holes for a pin or spanner wrench. This holds them firmly and true for grinding, and can, of course, be used for flat disks as well as for those shown.

Expanding Mandrels

All work that is turned after being bored goes on an arbor like Fig. 6. This is not new but it is a good one. The arbor *A* has a slight taper which fits the taper in sleeve *B*. This is drilled, as shown, and slots are milled to meet the holes. It expands very evenly as the arbor is driven in, and gives entire satisfaction.

Turning Long Bars

The spindle of a boring machine wants to be about as nearly right as modern methods will allow, both as to roundness and diameter. The usual method is to grind spindles or bars of this kind, but this method has not proved satisfactory in this case, and they are being turned, with excellent results.

The first step was to get a good lathe and mount it on brick piers at intervals under the bed. The next was to line up not only the spindles but the ways. A large scraping jig, if it can be called that, was made to span the ways just as the carriage does, and this was made about 6 feet long to show any inequalities, either in hight to the centers or in "wind" of the bed. This was carefully planed and scraped, and then placed in the bed to show the inequalities of the V's. The V's were then scraped to the jig and a very accurate lathe was the result.

Lining up the Bar

The first step after the bar is put in the lathe is to spot a place for the steady rest, and then take out the sag due to the weight of the bar. A lathe indicator is used for this so as to insure its being turned straight. It is tested every time the steady rest is moved, this being found better than a follower rest in this case.

The bars run up to 17 feet in length by 4½ inches in diameter, with 3¼ inches diameter and 10 feet in length as the most common size.

Heller high-speed steel is used in turning, the roughing cut reducing the stock about ⅜ inch in diameter at a cutting speed of 60 feet a minute. The tool is about the usual shape for roughing, though having a somewhat smaller curve than for heavy work, to avoid springing the bar.

Letting the Bar Rest

After the bar has been roughed down nearly to size, it is put on a rack to rest for as long a period as the rush of orders will allow. This varies from two days to a week as a rule, and is done to allow the internal strains to adjust themselves after the outer skin of the bar has been removed. The stock is 0.030 to 0.040 carbon steel.

The finishing cut is taken with a tool nearly a diamond point but the point a little flattened to take out the feed mark, and yet not wide enough to chatter. The last cut is 0.015 at 60 feet a minute cutting speed and a fine feed. The result is a very finely turned shaft.

Any stray tool marks are removed with a well worn, dead smooth Grobet file, after which the spindle is brought to size by careful lapping. The lap is a cast-iron sleeve, Fig. 7, between two and three times as long as the diameter of the shaft.

This is split on one side and the diameter controlled by the clamping screws *C C* and the stop screw *S*. The handles *H H* are pieces of pipe screwed into the casting for holding it and moving it along the shaft. This is set to the desired diameter, and flour of emery and oil are used for lapping. The reduction of diameter in this way is very slight, only the minute "high spots" being lapped down. In fact after this is done, the lap begins to heat and will do no more work.

While this method is contrary to that of many shops at this time, the fact remains that the shafts measure up very well indeed with a micrometer, the variation at points tested being less than half a thousandth, usually about a quarter.

The bars handle well in the boring mill and the results are very satisfactory to the builder. C.

The pumps used for clearing the anthracite mines of Pennsylvania handle over 500,000,000 gallons of water per day.

The Accuracy of Weighing Scales

No one can live long in Bombay without observing the freedom from restraint that is evident among users of scales and weights. Scales of all sorts may be seen—some with wooden beams, evidently home made—others of recognized pattern, on which are used chunks of stone and odd pieces of iron by way of weights. Silversmiths still use the red seed of the acacia or the wild licorice for weighing the precious metals, oblivious of the fact that the weight of seeds is not constant, and that they may readily be exchanged for others of less or more weight. A similar freedom may be observed among measures of length in spite of the very low price of the English foot-rule. There must, however, be in the city many merchants who are interested in having correct scales, and these may be interested in some details of the new board of trade regulations proposed to be put in operation in England.

The table of sensitiveness given in the new regulations proposed by the standards committee is as follows:

Capacity.	Sensitiveness When Fully Loaded.	Greatest Error Allowed in Excess or Deficiency When Fully Loaded.
1 lb.	20 grains.	40 grains.
2 lb.	28 grains.	2 drams.
4 lb.	40 grains.	3 drams.
7 lb.	2 drams.	4 drams.
14 lb.	3 drams.	6 drams.
28 lb.	4 drams.	8 drams.
56 lb.	6 drams.	12 drams.
1 cwt.	8 drams.	16 drams.
2 cwt.	12 drams.	24 drams.

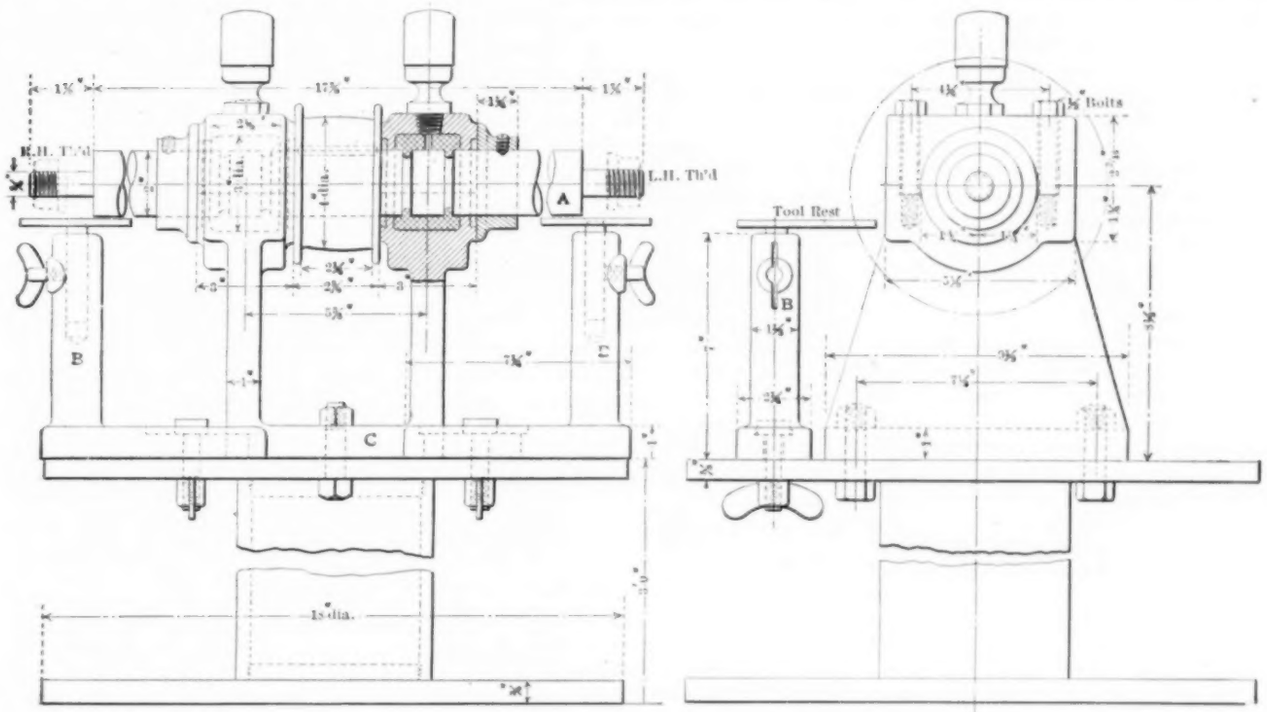
As one pound is equal to 7000 grains, the scale must turn when 20 grains are added or deducted from the weight. This is equal to 1/350th or 0.28 of 1 per cent. When the load to be weighed is two hundredweight, the sensitiveness required is ¾ ounce, more or less, to turn the scale, and a maximum error of 1½ ounces. These figures represent fractions of 1/4778th, or 0.000209.

Regarding the verification of spring balances, the inspector may, if he thinks fit, test the balance for efficiency to recover by leaving on a load equal to the maximum capacity of the machine for a period of 24 hours or less, and then, after the expiry of one hour, test for accuracy. The error allowed for spring balances is one and a half times that for counter machines. Spring balances are generally recognized as inferior in accuracy to beam or lever scales, but their convenience in rapid weighing makes them very useful. It is, however, well to know that the same peculiarity that affects the life of files, drills and hack saws applies to springs. The spring-balance maker has to make a separate index for every spring by hanging increments of 5 or 10 pounds of dead weight on the hook, and no two indices are exactly alike.—*Indian Textile Journal.*

A Toolroom Grinder

By Bayard

The accompanying sketch illustrates in detail a tool grinder which was designed for general use around the numerous toolrooms of a large manufacturing company. It is the policy of this company, however, to have most of the tool grinding done by men in the different toolrooms who are employed to keep all tools ground in good shape and placed in proper tool racks for distribution. These toolrooms are also fitted with the up-to-date grinders of the best makes, yet the grinder here shown is favored on certain classes of tools.



A TOOL-ROOM GRINDER

The piece-work system is used on most of the work, and of course the machinist wants to get out as much work as possible without any unnecessary delays; and it was found that the men on this work were more or less handicapped by having to carry a particular tool to the nearest toolroom to have it reground. The management finally decided to have constructed several small grinders and distribute them through the different shops where they were most needed.

How They are Made

The grinders were made as shown in the accompanying sketch, and they have been of great service and convenience. On each end of the spindle *A* is mounted an emery wheel 8 inches diameter by ¾ inch thick, one of coarse-grade emery, the other fine. These are driven at a peripheral speed of 5000 feet per minute. The bearings are of hard babbitt metal lubricated through a small oil cup. On each face of the bearings is a felt washer ¼ inch thick, which has proven very satisfactory both in preventing the leaking of the lubrication and in keeping the powdered emery from the bearings. At each wheel is a tool rest *B*, made adjustable in all directions. The stand is made of a piece of 6-inch heavy cast-iron pipe with a cast-iron plate 18 inches diameter and ¾ inch thick screwed on each end. To this top plate are bolted the adjustable tool rests and the bearing frame *C*.

A rather peculiar feature is the two grooves turned in the journal. These are not entirely filled by the babbitt and it is found that a film of oil runs in these grooves and aids distribution.

Iron free from carbon is said to alloy with copper without difficulty if melted in a clay crucible with a covering of flux to prevent the absorption of any carbon. Whether this has a commercial value or not remains to be proved by experiment. So far there seems to be no information beyond the mere fact that such a mixture is possible.

The American consul at Nankin utters a caution to his fellow countrymen, who spend lavishly on illustrated catalogs on thick paper handsomely bound, which appear to be highly prized by the Chinese at Nankin, where the supply is at times unequal to the demand. As the English language is not yet a general accomplishment among the citizens, the consul made inquiries and discovered that the leaves of the catalogs were being used as inside soles for shoes.

Sammy's Shop—Where do Costs End and Profits Begin?

By W. Osborne

Some wise man, or, perhaps he was a wise man, has said, "It does not pay to know too much." Without trying either to prove or disprove the assertion Sammy found that whether it pays or not it is not always pleasant to keep on finding out new things. His system of bookkeeping was not an elaborate one. He knew that when he did work and paid off all his bills and had something left that he was making money, or, at least, there was a time once when he knew this. Afterward there came a time when he began to have his doubts about it.

An Alarm in the Night

One night he was aroused by an alarm of fire. The light came from the direction of the shop. He came as near flying in getting there as he could, and regretted that he could not do better. When he got there he found that it was not his place that was on fire but that it was one quite near. It did not do him any more damage than to scare him, and to set him thinking. The insurance rates for shop property had always seemed to him altogether too high for him to be able to carry enough to give much of a protection, and he could not but see that a bad fire would leave him in a very bad fix.

Valuables Not Inventoried

It would take much more than all of his profits to make up for it. He knew

that he had a lot of things lying around that cost money to make, were used constantly in the work, and yet did not appear to be of value. You can hardly put a value on those pieces of flat iron that you drilled for holding down that last job. You hung them on the wall, and they will come in handy for the next job that is something like it, but you didn't think them of much real value. You wouldn't give five cents for them, would you? For all that, it took you more than a half-hour to lay them out and drill them and they weigh eight pounds, and there are a lot of other contrivances around that you and the others use from time to time. Sammy had a lot of such things accumulating on his hands that were not usually inventoried among the valuables. At the same time a fire would reduce or destroy the value of most of them. Just now he was afraid of fire. A lumber yard starting in as a neighbor, with a planing-mill attachment, did not lessen his risk any, and neither did a livery stable across the way. He spoke of these things to his bookkeeper.

Some Expert Advice

"You should charge off a certain amount from the value of everything each year, so that by and by you would have enough to pay for your place if it did burn down; and you should do the same thing with the tools, so that when they wear out you can throw them away, that is, sell them cheap, and get new ones."

The idea amused Sammy. "You are a good bit like the Dutchman I once heard tell of, only he carried it not quite as far as you do. He used to sell for less when he had to charge it than he did when he got cash. Said that he would lose less if the bill was never paid. If he had cut the bill down a little every few days I suppose by the time it was all cut away he would have had enough to buy some more goods—which is just like the scheme you are telling me about."

"Charging Off"

His ways of looking at things and of expressing his ideas were so different from those of the bookkeeper's that it took a lot of explaining before they understood each other's positions. Gradually it began to be clear to him that this "charging off," if honestly and intelligently done, enabled him to get at a nearer real value of his establishment, and could be made a means of making him his own insurer to some extent. It did not make any money for him, it is true, but it did help him to see clearly whether he was really making any for himself or not. It did not take much argument to show him that if a tool did not bring him in enough profit before it was worn out to more than pay for itself, it was not bringing in enough. Either it was a poor tool or else he was not charging enough for its use. In the same way he was led to see that he had to provide for deterioration in his buildings, and it was only a step further until he could see that he must provide for certain business risks. His insurance was only a way that he took to make someone else take the responsibility for him to some extent in case his buildings should be damaged by fire.

Further Good Advice

There were some things that he could not have anyone insure him against, and his bookkeeper argued that if he did not insure himself against these things he was not laying the foundation for a permanent business, and the only way to do it was to set aside a certain amount that experience would show to be necessary to take care of them. Until such matters were taken care of by the income of the business along with the wages, material, interest on borrowed money, taxes, insurance, supplies, etc., he could not be said to be making money.

Examination of Old Accounts

This bookkeeper was something of a hustler. He went digging back into all of the old accounts and brought them all to Sammy's attention. It was surprising how many of them there were that gave small hopes of ever showing any returns. Here was a man who was dead. No other information concerning him could be obtained. Here was another one who had vanished. Where to, nobody knew. This one had drilled so many dry holes that he had taken to wetting his insides so much with liquor that he had "gone to the dogs." Another one had flown too high and landed in the hands of the sheriff, who had not been able to extract anything from him that had been of any use to Sammy. There was a man who was honest enough to pay if he ever got where he had anything to pay with, and another one who never would pay no matter how able he might be to do so.

Losses and Gains

Not to take the chances which made such accounts a possibility meant not to do business, yet when all such losses were added up they made quite a sum. As he could not get the money they represented he could not but see that he had not made it.

Going over some work that he had done by contract he found that if he took account of all such things he was not making anything on them, but he also saw that if he did twice as much of it in the same time, by adding men to his present force, he would come out very well. As he saw the importance of keeping all of the wheels turning he began to make various things to carry in stock and sell, so as to be able to avoid any gaps in the men's time. As these things accumulated he began to get a bit nervous, for he found that it was easier to make them than it was to sell them.

A Sales Department Added

One day a man struck him for a job, said that he was willing to do anything, for work was scarce just then, but that he had been a salesman before he drifted into the oil country. The idea came to Sammy that it might be a good idea to see what he could do in drumming up trade in the stock stuff, and he took him on for a trial at it. The man made good, and it was not long before Sammy found that he had added the perplexities of a sales department to his other departments. At the time this man was taken on, the shop was quite slack; and after the new man had been taken all around and the facilities of the whole establishment explained to him, he was told to sell anything that they had on hand or anything that they could make. He believed in following instructions, and in a short time Sammy was receiving all sorts of orders, and tips as to the prices at which the goods must be supplied.

Information Regarding Prices

The shop needed work, yet some of these prices made Sammy wince. At first he thought the man must be mistaken as to the price other makers sold things for. When he found that he was not he began to hunt around to find out how such things were made by others who were in the business. Of course, there were many jobs which could be done at a profit, but he found that the kind of orders which called for many things of one kind and size almost always were the kind which called for more of a reduction in price than he was able to make with his present equipment. He felt that he must take care of the work and soon began putting in special machines, and then he had to reach out for more work to keep them busy. He also found that he must modify his instructions to his salesman. Perhaps he *could* do *anything*, but he had to admit that he did not care to try it, at least, when it came to making a few pieces of the things which other people were making a business of making in large quantities.

Successes and Failures

All of his ventures were not successes by any means, but once in a while he would make a hit. It was as apt as not to be on something that at first he had failed to meet prices on, and had either to give up or find better methods of doing. Naturally he disliked to admit defeat and so did the men who were doing the work. This made everybody willing to receive new ideas and to try to get the best out of them. If the job was one that could be done at the price by anybody with the appliances at hand, they had a good chance to stay inside of the limit, at least.

Sometimes a job looked exceedingly

simple until after they had undertaken it, and then as soon as they got well into it they met troubles that they were not able to overcome in a commercial way. At other times they hesitated about undertaking something that afterward proved to be as easy as "rolling off a log," as the boys used to say.

PROBLEMS GROW WITH THE BUSINESS.

Whether he was really making any money or not was not always clear, but he was sure that he was getting out more work and furnishing work to a larger number of men as time went on. At first it had seemed like the simplest thing in the world for a man to tell whether he was making any money in his business or not, but the deeper into the matter he went and the larger and more complicated the business grew the less positive he became.

Here was the way things would sometimes work: He would make up a lot of forgings for which there seemed to be a growing demand. As near as could be known these forgings cost 29¾ cents each and were sold for 40 cents. That would give a very nice profit if they could be sold at once and without any further expense, but every day they lay in stock added to their cost, and every time one or two were sold and gotten out and delivered to the customer it took the time of a well-paid man, and it was no unknown thing to have the demand suddenly stop entirely because of some other device supplanting them. Supposing they were finally all sold how much *net* profit had been made on each one? Not the 25 per cent., you may be sure, or it would not have been so hard to tell whether there was any profit or not.

CONDITIONS UNDER WHICH MONEY MIGHT BE MADE

Sammy felt sure that *if* it did not cost to advertise, and *if* it did not cost to have salesmen, and *if* it did not cost to carry stock, and *if* it did not cost to use borrowed money, and *if* it did not cost to collect bills, and *if* it did not cost to do the clerical work, and *if* there were no more important *ifs* to interfere, he would be making money "hand over fist;" but *if* there was anybody in the business who was staying in and getting along without any of the above costs, he did not know it.

Costs had begun to broaden out in his mind since the time that he was a machinist working for someone else.

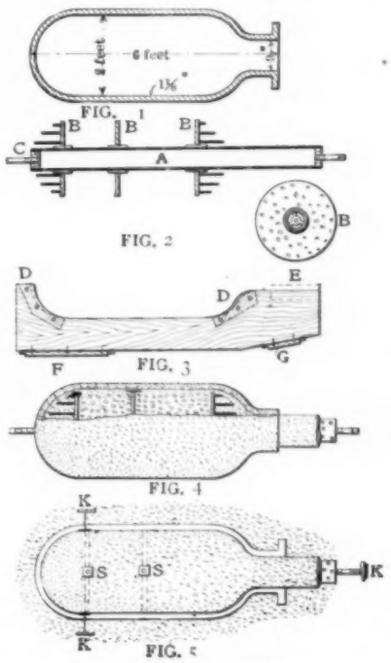
The introduction of electric railways into the Alpine districts of Switzerland has been the means of establishing a new and somewhat strange industry—the quarrying of ice, which is of superior quality, from the glaciers. A high degree of engineering ability has been exercised in erecting slides with numerous curves to avoid excessive speed in the downward journey of the ice blocks.

Molding an Air Vessel from a Loam Pattern

BY G. BUCHANAN

Many castings which do not present any unusual features in molding are nevertheless liable to turn out wasters if experience, probably gained by previous failures in similar work, is not brought to bear in a practical way to carry the various operations through to a successful issue.

An example of the above class of casting is shown in Fig. 1. This piece, called in the present instance an air vessel, weighs about 1400 pounds. The principal sizes are given on the sketch and the mold is in green sand. It is generally cheaper, and quite as good practice, to prepare a loam pattern when making air vessels of



MOLDING AN AIR VESSEL

the size shown, as it is only necessary to sweep a thickness of loam on to the core to get the pattern, while making a wood pattern would entail considerable expense. Even if a skeleton wood pattern was made, the cost would be many times that of one made of loam.

On account of the small opening in the vessel a small core bar has to be used. Fig. 2 is a sectional view of the core bar; *A* is the bar, *B B B* are three open sand-ring castings wedged on the bar, the rings at either end being provided with pegs to carry the loam. Into the front end of the core bar is screwed a removable spindle, used when spinning the core and afterward removed, and the opening is securely plugged.

SWEEPING FOR CORE AND PATTERN

Fig. 3 is the sweep used for striking up both core and pattern. As shown it is prepared for the core; when used for the pattern, the two pieces *D D* are removed and the piece *E* is fastened to the sweep. The strips *F* and *G* are the sizes of the core and the pattern respectively. The core bar is placed on trestles and hay ropes are spun into the spaces between the ring castings. Clay is coated over each layer of ropes until the spaces are filled. A coat of loam is next given to bring the core to within say ⅛ inch of the required size. The spaces at each end of the rings with pins have been previously filled with core sand. The core is next placed in the oven and, when dry, is given another coat of loam to bring it up to the exact size required. It is again dried and blackened, and the thickness swept on. A small straw rope is used for this purpose, spun closely on to the finished core, and loam is swept on to complete the shape and size, the end of the pattern. Thickness is obtained by driving flat-headed nails into the core and then ramming core sand on to the required thickness. The pattern having been dried, it is ready for use, a pair of ordinary pipe flanges being fitted to the neck end of the pattern.

THE LOAM PATTERN

Fig. 4 is a view of the loam pattern part sectional. As the molding of this piece is very ordinary practice, the only point worthy of notice is the securing of the core in the mold. Two chaplets are driven into suitable blocks in the bottom of the mold, and come exactly under the two rings in the core, *S S*, Fig. 5. Two side chaplets are placed at the joint to prevent any side movement, and two ¾-inch studs are put in the top part in the same position as the bottom chaplets *S S*.

SECURING THE CORE

Great care is taken that the two top studs are perfectly straight up and are resting on the iron rings in the core, as otherwise the core will lift when the mold is poured and a waster will be the result. *K K K* are flat bars driven into the floor to provide stays for the two side chaplets and also for the end of the core bar. In pouring, a hot rod should be placed well into the end of the core bar with a few shavings, as when the escaping gases are not lit at once they sometimes explode and cause damage to the core, portions of the loam being shaken loose and floating in the mold. The result would be anything but what is desired, but, strange to say, the molder is always looking for it.

James Nachtwey and Charles Schultz, of North Fond du Lac, Wis., are reported to be building a motor sleigh equipped with a 10-horse-power air-cooled engine. Propulsion will be by means of a steel wheel, 4 inches wide, with prongs. This wheel is chain driven by the engine, and the prongs are of sufficient length to get a good purchase on snow or ice and propel the car.

Tooth Relief for Milling Cutters

By H. T. Millar

It is popular belief that sharpening milling cutters with a face emery wheel gives flat relief as in Fig. 1. While this is true for teeth cut straight across the cutter, it is not true for teeth cut spirally as slabbing cutters are generally made. The relief for cutters with spiral teeth when ground with a face wheel is convex, as shown in Fig. 2, the amount of this convexity being dependent upon the angle of tooth spiral and the breadth of the emery wheel in contact with the cutter tooth. In fact, the radius of the curvature of the relief varies directly as the tangent of the angle of tooth spiral and inversely as the width of emery wheel in contact with the cutter tooth.

It will be convenient here to refer to Fig. 3 which shows enlarged a portion of a tooth of a cutter 3 inches in diameter, spiral of tooth 15 degrees, with part of a face emery wheel in contact with it; also five sections taken along the emery-wheel face. It will be noticed that there is a distinct difference in the angle of relief ϕ at the different sections. This, of course, is due to the fact that the front of the tooth is practically a radial line, the end moving in an arc of a circle. It will be seen from Fig. 4—which shows the five sections, Fig. 3, superimposed—that if the cutter were not passed across the emery-wheel face, the tooth would have a relief angle which was different at each part of its length. However, as every part of the tooth relief passes right across the emery wheel it follows that the outline of the tooth relief is constant, and that every part of it receives the effect of the variation in ϕ noted above. Considering only the effect of the five sections shown on Fig. 3, the resultant relief would be somewhat like Fig. 4. If more sections were taken there would be a greater number of flats, until with an infinite number of sections the relief would be a curve as shown in Fig. 2.

It may be interesting here to follow the subject up and to find out the radius of curvature of the relief for the example noted above. If AB, Fig. 5, represents the relief, then AC and BC are the radii of curvature where AC and BC are at right angles to the tangent to the relief arc. To find the length of AC it is only necessary to know the angle ϕ and the circular distance AB. These can be got from a layout like Fig. 3, and we find that the radius of the relief is practically 1¾ inches, a result hard to realize, perhaps, though the slight width of the relief, in a new cutter not more than 1/16 inch, would not show any curvature that was not great. Again the average result obtained in practice may not be so pronounced since the amount of emery-wheel surface assumed to be in contact with the cutter tooth, 5/16 inch, is rather greater than generally occurs in practice for fear of drawing the temper of the cutter.

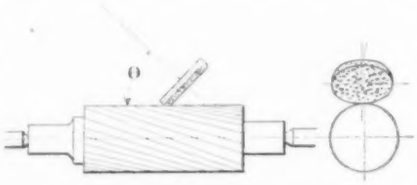


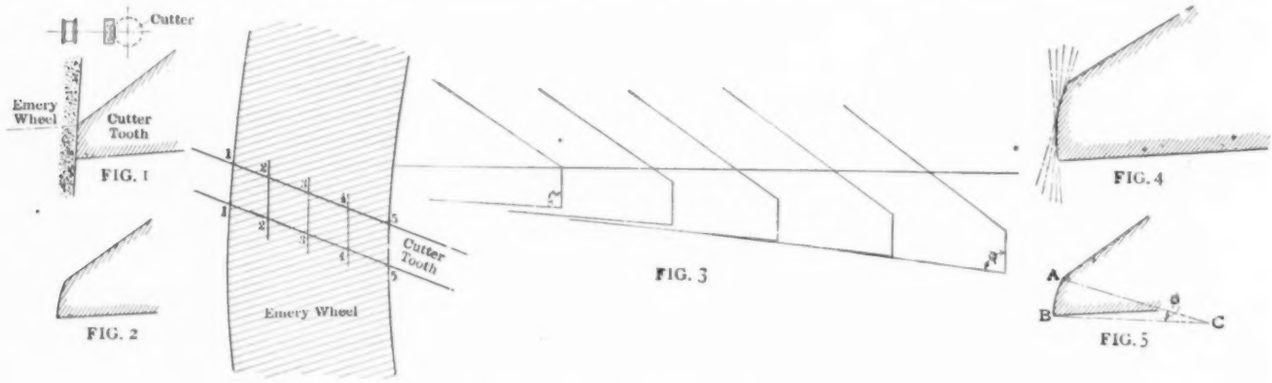
FIG. 6. RELIEVING WITH PERIPHERY OF WHEEL

Now this convex effect of the spiral occurs in the same manner when sharpening with the periphery of an emery wheel. In fact its effect can be great enough to negative the concavity produced by the emery-wheel radius, and produce a straight relief. The concave effect of the wheel radius depends on the diameter of the wheel, and the angle it is set over, θ, Fig. 6. This is generally between 45 and 50 degrees. As is evident from the end view, the grinding face presented to the cutter tooth is in effect part of an ellipse, which materially increases the radius of what might be called the grinding arc, that small portion of the emery wheel in contact with the cutter.

When sharpening with the periphery of a wheel there are thus two effects counteracting each other, the concaving effect of the emery-wheel radius just shown, and the effect of the tooth spiral tending to make the relief convex. These effects may, and sometimes do, neutralize each other and produce straight relief, but more generally the relief is concave.

The convex relief being desired on account of its strength, it might seem that we would only have to increase the length of contact between the emery wheel and the tooth to gain a convex relief irrespective of the method of grinding. There are, however, conditions which limit this, the chief one being the danger of drawing the temper of the cutter.

Manchester, England.



TOOTH RELIEF FOR MILLING CUTTERS

Denatured Alcohol and Acetylene Gas for Motors

The effect of the passage of the denatured alcohol bill on internal-combustion motors is yet to be determined, but experiments tend to show that it can be used with fair success.

It has been found that denatured alcohol alone, without mixture of other fuels, was not suited for engines running over 400 revolutions a minute, owing to its being slow to vaporize and slow in igniting. Joseph Tracy, the daring driver of the Locomobile in the Vanderbilt races, has developed a scheme of using acetylene gas in combination with denatured alcohol. For starting he places a small charge of carbide between the carbureter and the motor, and pours on this a little alcohol diluted with 17 per cent. of water. This generates enough gas to start the motor and warm the cylinder, and as it runs, the atomized alcohol passes through a bed of calcium carbide, giving a combination of air, alcohol vapor and acetylene gas, which he calls "Alkothine," about equal to gasolene in power but costing somewhat less. His tests have been made with a 3½-horse-power De Dion motor running 1500 revolutions per minute, indicating that he has overcome the former limitations regarding speeds.

At the present price of the metal the copper mines of the world are mining at the rate of exactly $1,000,000 a day for every day in the year.

Calculating Butt-strapped Boiler Seams

In calculating the strength of butt double-strapped joints advantage may be taken of certain short cuts to determine the weakest portion of such joints. This type of joint as usually applied to boiler construction is represented in Figs. 1, 2 and 3 for double, triple and quadruple riveting, respectively.

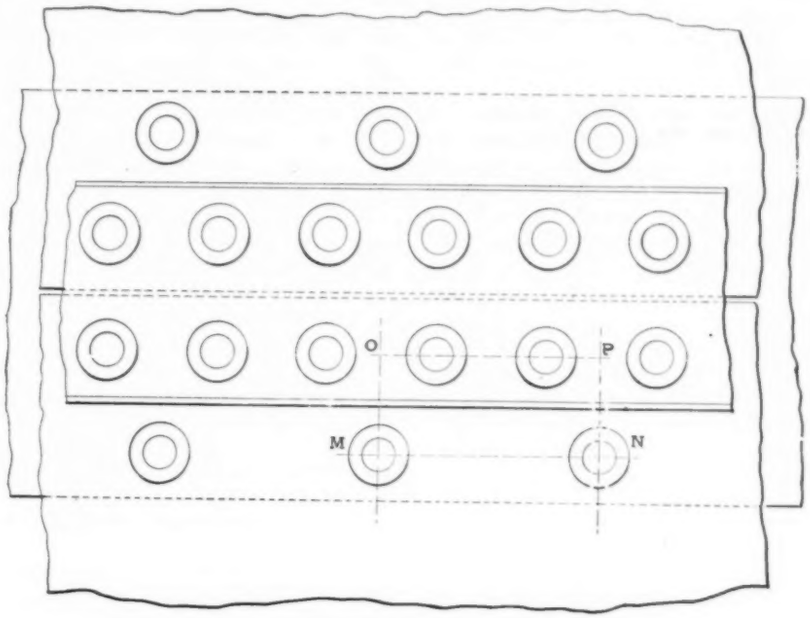


FIG. 1. DOUBLE-RIVETED JOINTS

When it is desired to find the efficiency of a joint like the one indicated in Fig. 3, for instance, the general procedure is: First, calculate the strength of the section of shell between the rivet holes *A* and *B*; second, calculate the strength of the section of shell along *C D* and add the strength of one rivet in single shear. third, calculate the strength of section of shell along *E F* and add the strength of three rivets in single shear; fourth, compute the strength of all the rivets in single and double shear, respectively, included in the space *A G H B* (the rivets at the lettered points of course being considered only as half rivets). The smallest of the above results is then divided by the strength of a section of the shell of a length equal to that of the outer pitch, or the distance from *A* to *B* center to center; this gives the percentage of the strength of the joint as compared with the solid plate.

It will be readily seen that quite an amount of labor is expended in obtaining results that are of no practical value in getting the final result, except that their relative values must be known in order to select the lowest. If this relation between the three values can be ascertained by any simpler means, it will lessen the work of determining the final result.

It will be noted that the strength of the section of shell *C D* plus the shearing strength of one rivet would be exactly equal to the strength of section of shell between the rivet holes *A B* if the section of metal removed from the plate by a rivet hole were just equal to the shearing strength of a rivet, for this section *C D* would then be decreased in strength below *A B* in drilling the extra rivet hole by exactly the same amount added in shearing the rivets in the outer row. With the same relations between the thickness of plate and diameter of rivet holes, the strength of section of shell along the section *E F* plus the strength of three rivets would also have the same value as section *A B*, so that a joint constructed of such proportions between plate and rivet holes would be theoretically as liable to fail along any one of the three sections *A B*, *C D*, *E F*.

If we assume that the plate is increased in thickness while the rivet holes remain the same, the strength removed from the inner section by drilling the extra rivet holes would not be compensated for by the shearing of the rivets in the outer rows, and the inner section would become the weaker; conversely, if the plate was decreased in thickness, the outer section would be weaker. It is obvious that if one knows whether a plate in a given joint is above or below the thickness that would make that joint equally strong in each of the sections, one can tell whether the weaker section is the outer one or the inner one.

In using this method for calculating a joint, we would first find the shearing strength of a rivet, and then multiply the thickness of the shell by its tensile strength, and by the diameter of a rivet hole, and if the strength of the rivet were less than the product of these, then the inner section would be the weaker, or otherwise the outer section would be the weaker. If several joints are to be figured, or if joints are frequently figured, a table should be prepared, as below, which gives the thickness of plate for various-sized rivet holes, at which the joint would be equally as strong at each of the three sections mentioned; the equation for getting these thicknesses would be:

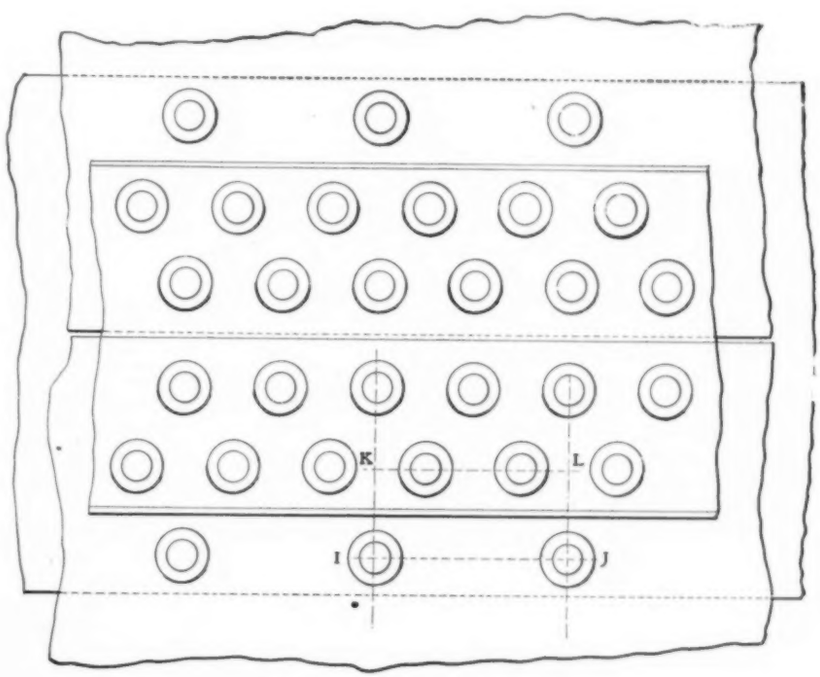


FIG. 2. TRIPLE-RIVETED JOINTS

$$Thickness = \frac{shearing\ strength\ of\ one\ rivet}{dia.\ of\ rivet\ hole \times tensile\ strength\ of\ plate}$$

The values assumed in this table are 60,000 pounds tensile strength for plate and 42,000 pounds shearing strength for rivets.

PROPER THICKNESSES OF PLATE TO MAKE RELATIVELY STRONG JOINTS

Diameter of Rivet Hole.	Thickness of Plate.
$\frac{1}{4}$ inch.	0.38 inch.
$\frac{5}{16}$ inch.	0.45 inch.
$\frac{3}{8}$ inch.	0.515 inch.
$1\frac{1}{16}$ inches.	0.58 inch.
$1\frac{1}{8}$ inches.	0.65 inch.

It will be evident that with the aid of such a table it is only necessary to know the thickness of plate and size of rivet hole in a given joint to determine at a glance whether the outer or inner section is the stronger. Of course, where it is necessary to compare the strength of this weaker section with the strength of all the rivets in both single and double shear, their value must be determined in the usual way and compared with the strength of the section previously determined, but for joints constructed like Figs. 2 and 3 it will be found that the strength of the rivets generally exceeds the strength of the solid plate and unless the joint is of abnormal proportions, the strength of the rivets as a whole need not be considered; however, in the double-riveted type of joint as indicated in Fig. 1, it is well to consider this mode of failure.

It may be well here to point out the fact that in quadruple-riveted joints, as shown in Fig. 3, section *C D* can never be the weakest of the three and therefore it need never be considered in making calculations of such joints. The same methods of calculation as outlined above may be used for the double- and triple-riveted joints, and I am certain that anyone who frequently, or even occasionally has to compute the strength of such joints will never return to the laborious method of considering the strength of each mode of failure individually after trying this short cut.

There are other methods of failure of joints of this description that have not been considered, because they are not usually taken account of in the calculation of joints already constructed, as the design of such joints is supposed to render other modes of failure than those given improbable.—*Power.*

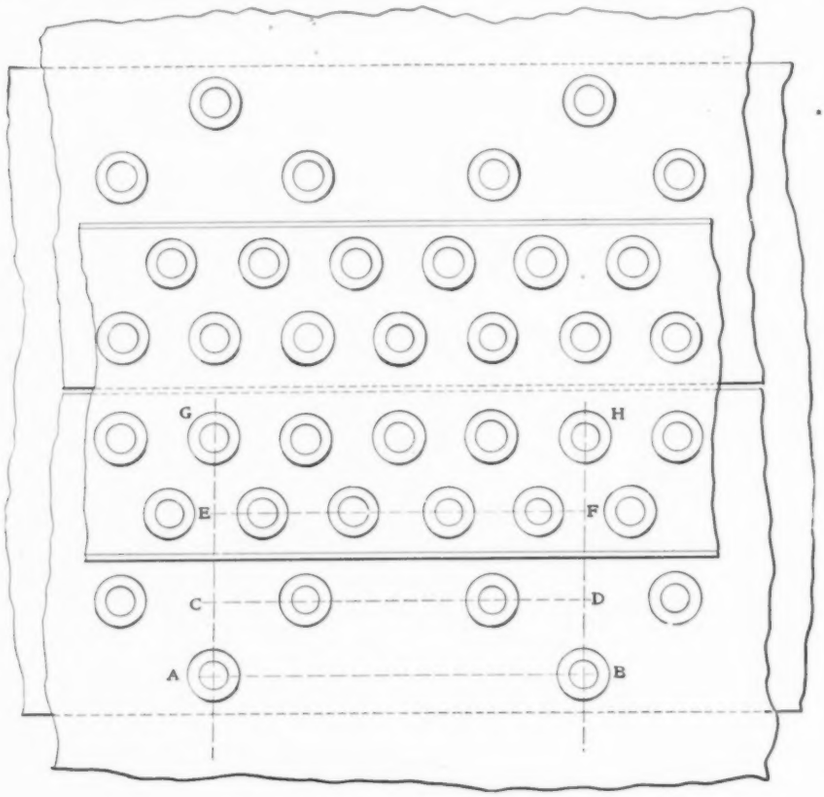


FIG. 3. QUADRUPLE-RIVETED JOINTS

Hardening Drills

Hardening an ordinary drill in sulphuric acid makes an edge that will cut tempered steel or facilitate cutting hard rock. The acid should be poured into a flat-bottomed vessel to a depth of about $\frac{1}{8}$ inch. The point of the drill is heated to a dull cherry red, and dipped in the acid to that depth. This makes the point extremely hard, while the remainder remains soft. If the point breaks, reharden but with a little less acid in the vessel.—*Compressed Air.*

Enlarging a Hole for a Propeller Shaft Tube

By George Howe

The cutting off of rails, bolts or other metal when encountered in an auger hole in wood is always a nasty proposition. Let the length of the hole be something like four feet, and the obstructions the ends of some six or eight ½-inch bolts, and the job is all that can be desired in the way of cussedness.

We had a launch hull all ready for the engine when the customer suddenly changed his mind and decided that he wanted a reversible wheel instead of a solid one. Ordinarily this would have made no difference, as we aimed to make the holes in the shaft log large enough so that either solid or reversible wheels could be used. On a reversible wheel the shaft is inside a tube, the tube being moved axially by means of a lever and notched quadrant, to give the required movement to the blades. In this case it was found that the tube of the wheel furnished with this make of engine was extra large, necessitating reboring of the shaft hole.

The shaft log, which is the wooden block extending inboard from the stern post, was in halves, the lower part being bolted to the lower part of the keel, and the upper one bolted to that. It was found that if the hole in the log was enlarged to the required diameter for the shaft tube it would be necessary to cut a little from the ends of the bolts, eight in all, and the hole was but two inches in diameter. It looked like a new wheel and shaft for Mr. Customer, who was a foreman in a large factory.

He said he would get a large twist drill from the works, have a long shank fitted and bring it around. When the drill came we started it in the hole. The lip of the drill got hold of the first bolt end and we strained until the log threatened to split without budging the drill. I wished that I was in the mining country, and could run a diamond drill in that hole. However, the diamond drill gave me an idea. Procuring a piece of steel tube about ten inches long, and the same diameter as the hole required, I cut a series of teeth on one end, giving them a slight outward set. The teeth I then case-hardened. For turning the bit I attached to it a length of ¾-inch pipe, fastening it by means of a pin through the ends of tube and pipe. The pin was made a loose fit through the end of the pipe shank so as to allow the cutter to float freely in the hole.

We bored in with a wood bit until a bolt was reached, and then cut the latter off with the cutter. It was slow business, but did the job. We had to reharden and sharpen the cutter several times during the job.

The Molding Machine In Actual Practice

Considerations of Its Adaptability to General Work, the Percentage of Poor Castings and Its Improvement through Co-operation of Molders

BY R. H. PALMER

That the molding machine occupies a very important place, and is one of the necessary equipments of a modern foundry to enable it to produce duplicate castings economically in quantities, is freely acknowledged.

Its influence is felt by the employer in the cost of production and by the employee physically and in many instances in his earnings.

While not filling all the requirements of the molder's art, it has proved itself one of the steps of advancement in progressive foundry practice and, when in the hands of an interested and intelligent molder or handy man, much more can be accomplished on it than is generally conceded.

It has met with opposition from the molder, as he claimed the increased output of the machine increased his physical labor, and the machine was doing the easier part of the work. But no opposition will stop the introduction of the molding machine as long as the employer can see it is a paying investment, and the quicker the molder lends a hand to improving it, and his output on it, the quicker will the machine be improved and equipped to lessen labor.

Opposition has brought out many improvements to help introduce it, and the handy man, if intelligent and of progressive nature, soon learns to operate the machine at a profit to his employer and himself.

Men Trained to Do One Thing

I visited one large foundry where all the work was made on machines, and saw molds made very quickly and nicely by men who had been taught to make that one particular pattern on that machine, or a few patterns, and all they knew about the business they had learned there. The loss at times in bad castings was large, but the increased output at small labor cost made up for the breaking in the men as molders, although it took time; and when they were accustomed to the work they stayed, as they could make better pay there than elsewhere.

At the present time every effort is being made in the foundries to increase output at a lower cost, not through any reduction in wages, as wages have advanced, but by the introduction of new methods of doing the work, and arranging the work in such a manner as to obtain from skilled labor and machines the greatest output.

With a large investment of capital it is not a question of first cost, as with the smaller foundries, but a question of what will the investment of certain capital pay?

Saving on Agricultural Work

An employer in an agricultural foundry was in favor of machines, but he had not obtained the best results from some he had on account of conditions. His foreman prevailed on him to get two hand squeezers, agreeing that he would save the cost of the machines to him in any event; and when he got the machines fitted as he wished, he would press up a number of molds and let his employer see that he could do as he said.

When the machines were unpacked and set up, the same snap flask was used with pieces added on drag and cope to deepen them to allow for the pressing. Rests were put into the drag for the bottom board to rest on when the board was pressed into it, and the same matches were used as with hand work.

The molder had been paid 3 cents each to put up 75 molds a day, and at that time it was considered good pay in that part of the country. On the machine he put up 100 molds at 2¼ cents, and his sand was cut up for him at a cost of 15 cents, whereas he had cut his own sand when making them at 3 cents. This made the cost:

By hand, 100 molds, 3 cents each.	$3.00
By machine, 100 molds, 2¼ cents each	2.25
	0.75
Cutting sand	0.15
Saving per day	0.60
295 days at 60 cents per day	$177.00
1 machine delivered $20.00	
100 bottom boards 5.00	
Altering flask 1.00	
	26.00
Saving, after paying for machine and equipment	$151.00

In another case a molder was receiving $3.25 per day, and putting 10 molds a day by hand, in each of which were two castings weighing from 18 to 25 pounds each, according to size, making the cost of molding each casting 16¼ cents.

Speed and Poor Castings

Two machines were fitted up, one to make the drag, and the other the cope, and a molder was put on each at $3.25 per day. These two molders put up 40 molds per day, in which were 80 castings, thus making the castings cost 8⅛ cents each.

But would the loss average the same percentage of bad castings in each case?

I found it did not. That where you increase the speed of production there is a greater liabilty of bad castings. Where the molder, putting them up by hand or rather without the aid of the machine, had one bad casting when they came to be machined, the two molders at times would have eight. This made the good ones on the machine cost 9 1/36 cents each, and molded without the aid of the machine, 17 2/19 cents each.

The question then arises, How much machining was needed before it could be determined whether the castings were good or bad? This was one cut on a flat surface, generally 4x5 inches when properly fitted for the machine.

The cost of fitting the patterns was not over $60, and the castings were made by the thousands, while the machines were used for a great variety of patterns, and the flasks on machine, bench, and at times on the floor.

Points to Consider

The purchaser of a molding machine has to take into consideration the number of each of the several kinds of castings he thinks can be successfully made on the machine; to what extent they are to be finished, and where; the cost of fitting patterns up for machine molding in the several different ways for the different machines, and the liability of a pattern to change; the liability to loss when fitted under certain conditions, and the best way to avoid it; which way he can get the greatest number of good castings, by having them rammed up by hand on one machine, or pressed up on another; the cost of equipment for the different machines as flasks, and foundry equipment in the way of handling flasks and iron.

Percentage of Loss

In a foundry where everything is made by machine, I was informed by the man in charge that the bad castings ran up to 20 per cent. at times, and that if they could get them down to 15 per cent. they would be well pleased.

The castings varied in weight from 500 pounds to 800 pounds each, I did not see any molds blacked, as I remember, but all the larger molds were faced with a sea-coal facing. When taken into the cleaning room they were put through the tumbling barrels. A gentleman from another large

plant told me their loss was anywhere up to 30 per cent., but the large figures were where they were breaking in new men on the machines. When they were running smoothly it was in the neighborhood of 15 per cent., but they might have a run of bad luck and have it mount up to more.

Selecting a Machine

Very often an employer will visit another foundry and, seeing a molding machine at work, become interested, and be told a wonderful story of what is being accomplished. With a heart full of envy for his fortunate neighbor he goes home, looks his work over, compares it in his mind with what he has seen and decides he will have some molding machines. He writes one of the firms engaged in the manufacture of molding machines: "I am going to put in a number of molding machines. Please send your man to see me."

With visions of orders, the molding-machine man walks into the office, and receives a welcome as the man who represents the machine that will help increase output and profits.

He is accompanied into the foundry to look the work over, and see if more of it could be made on the machines his firm manufactures.

He looks it over.

"Oh, yes; that could be made on the machine—certainly—yes—"

But every machine that is manufactured calls for a change in that particular pattern when it is used. There are never more than twelve of a kind, usually less. He looks over more patterns, but finds the amounts ordered did not come up to his expectations.

"Well, you have some patterns that you use a lot of? The only thing to do is to see how many of your people use in a year, and make in lots accordingly. You can save money."

"True, but do you take into consideration the cost of storage where ground rent is so high?"

Then he says good day, as he supposed conditions were different.

Paying for Experience

I refer to this to show what the molding-machine man goes up against sometimes. He is called to tell a man what kind of a machine to buy for molding certain kinds of work. An employer wants a machine that will take the place of the molder as much as possible. His neighbor has one and is beating him on his output, and he wants to get there, too. But he does not always take into consideration that the molding-machine man must have something to work on if he is to advise him intelligently, such as the amount of the output wanted of those particular kinds of castings, and the amounts and kinds of any other castings he may make in quantities, so in order to pick out a machine that is best to produce his class of work economically, with the least outlay for equipment for the machine. When the machine is set up, and ready for the molder to run it, he finds there is something more to it.

A machine molder is hired, having worked at So and So's. He finds the air pressure is different. He may find he is pressing the molds too hard and they blow in some cases; he presses them lighter on the cope side; they don't blow, but they come dirty when they are machined. He looks the castings carefully over and finds they show that the mold is cut on the drag side where the iron enters the mold and strikes on the face. He is more careful, uses his sand a little heavier, puts a little facing on where the iron strikes on the face, works in a little coarse sand, cools his iron down a little more, and he gets them all right.

The employer's neighbor has been through all of this fun of starting machines. It is the usual experience that when a new thing is started, difficulties have to be met and overcome. His neighbor showed him what he was then doing successfully, but did not give him all of his experience while getting everything to run right. He let him pay for his experience, as he paid for his. Had he given it freely it would not have been appreciated.

The old hand squeezer has turned out, and is today turning out, lots of good work where compressed air is used, but with the compressed-air machine, larger work may be handled and, as the operator gets more familiar with his machine, he can give his employer better and more work with a proportionate decrease in bad castings. There are many little tricks that machine molders resort to, to overcome some of the difficulties attending the successful operation of the machine.

Stripping Plate and Vibrator

With a stripping-plate machine it is costly to fit up to make castings on it, as the work must be accurate to have it work successfully. A good man is required and it takes time.

In order to do away with the stripping plate as much as possible, and also to help it, the vibrator was introduced. In some patterns with deep pockets it was hard to get a good lift, or draw the pattern. With the vibrator in use the same result is obtained as when the molder draws the pattern with one hand and raps it with the other, or has someone to rap it for him: a jar is given to the pattern.

On some of the larger stripping-plate machines, the mold is rammed up by hand, and the pattern is drawn down through a stripping plate by a hand lever. Before starting to draw the pattern the vibrator is started, the lever which controls the pattern thrown down and out glides the pattern, leaving the mold in perfect condition. On the compressed-air squeezer machine a lever is pressed by the knee, thus leaving the hands free for the molder to handle either cope or draw his pattern. In all cases the vibrator is fastened to the part of the machine to which the pattern is attached, in order to give it the jar, or vibration.

Molding Small Pulleys

Some pulleys were mounted on a board, and were to be pressed up on a machine using compressed air, in snap-flasks. The pulleys were some 3 inches in diameter on the inside of rim and perhaps 6 inches face with hub extending part way up in the cope, and down in the drag.

In using the board the molder parted his flask, and placed the board in the joint of the flask, then, placing it on the machine, pressed up his drag, rolled it over, and pressed his cope, started his vibrator, lifted off his cope and, starting his vibrator again, drew the pattern.

When the molds were poured, the iron did not lie to the top of the rim of the pulley, as it was pressed too hard. The molder then scooped out a little sand over each pulley, so the sand over the pulley would not be pressed as hard, vented the cope and nowel, worked in some coarse sand, and they did better. But the loss would be too large in the foundry and when they came to be machined.

Another pulley of the same style and nearly the same size was fitted to go on a machine where the mold was rammed by hand and the pattern drawn down through a stripping plate. This gave good results in the foundry and when machined.

Preventing Molds Bursting

In pouring snap flasks it is hard to choke up the gate to a mold without bursting the iron out the sides of the mold, unless there is an iron band rammed up in the mold at the same time, and left there when the flask is removed, or a properly fitting slip, as it is termed, put around the outside of the mold before pouring. Bands are often made of thin wrought metal, which look very nice, and are gotten up cheaply, but are found worthless when used, as they have no stiffness, and spring and let the iron burst through the sides of the mold when the pressure comes on them. The old-fashioned cast-iron band with a lip cast around the inside to give it stiffness proves itself much more acceptable to the practical molder.

Flasks Too Light

A firm in the East had taken a contract for a large amount of agricultural castings; they decided to put in machines. A man was sent to several leading firms to see how they were fitted up to do the work. Machines were bought, flasks made, and patterns fitted up. The machines were started, and the fun commenced. Pouring was a succession of "run outs." The flasks had been made light to be easy to handle, close to the

pattern to do away with ramming up too much sand; but parts of the casting would come heavy even when the iron did not run out on account of the flask giving to the strain.

Whose fault was it? Not the machine's. It was the fault of the man who designed the equipment for the machines. I called on him one day, and as we stood talking on foundry practice I asked him if those flasks were not a little light. He acknowledged making a big mistake in the flasks, that they were too light and too near the pattern, and said he was paying for it in spoiled castings. Flasks need not be so extremely heavy to obtain strength. The design of the flask and distribution of the metal sooner or later tell their own story.

The equipment for tempering sand and for handling it to the machines is attracting a great deal of attention in the large modern foundries. In one of them the larger flasks, rammed up on the machines are shaken out or dumped on or near gratings in the floor, so the sand falls into the cellar. It is there tempered and then raised to a bench near the molder, whose helper shovels it into the flask. The molds are handled by small electric traveling cranes over each floor. When ready to pour, the iron is brought down the gangway, taken by these cranes, and poured by certain men whose special business it is to pour the molds. At the proper time they are shaken out by another gang, and castings are run into the cleaning room by another. Each gang of men has its certain part to perform, and the molders are molding all day. All foundries cannot fit up in such an elaborate way, as their output of any particular kinds of castings would not warrant it.

The Roll-over Machine

On the other hand, there is a machine being largely introduced at the present time, called a "Roll-over" machine, which gives promise of much in the hands of a good man, and it is claimed the equipment called for need not be elaborate. The machine is so arranged on wheels that it can be moved back and forth on the floor.

If a number of overhead tracks are put up with trolley and high-speed chain block, and one of each of these machines is placed at the respective ends, one having the drag rammed up on it and the other the cope, and the parts of the flasks handled in this way from the respective machines, the labor cost can be decreased and quite a large flask used on the machine at a reasonable cost for equipment.

The board on which the pattern is mounted is placed on the machine with the drag and the mold is rammed. The pattern I saw used contained a large number of very thin green-sand cores. The molder riddled some sand into a heap and, taking it in his hand, threw it into the pattern, thus ramming up the pockets as any molder would do in such a case. He then shoveled in the sand and rammed up the mold by hand with a rammer. I should say the flask was some 38x16 inches. He did it in good shape, and it would send joy to the heart of any employer of labor to see molds rammed up as fast, and to see men working as that man did. The bottom board was *rubbed down so it bore on the flask*, clamped on to the pattern board and rolled over. The clamps were removed, the pattern given a good rapping with a heavy mallet, and a piece of gas pipe slipped on to the lever that was to draw the pattern. The vibrator was then set in motion, the lever to draw the pattern pressed down, and the pattern glided up out of the mold, leaving a perfect mold. As an exhibition it was fine, all that could be asked.

But I kept thinking. If a man molded up a lot of castings of that kind in that way, how many would he have to sell when they were cleaned up? There was no special reason for this, only I have seen a lot of things that experimentally looked very fair, but when one came to put them into practice it took quite a while to get all the kinks out.

In a Jobbing Shop

So I went to a jobbing foundry where it was used, but I got there too late to see the molder working it. The foreman was in favor of the machine. He told me, "When I have patterns come into the foundry where I can take one-half and use that to make both halves of the mold, I make a heavy saving, with some patterns 35 per cent., and others 25 per cent., with an average of 30 per cent."

I asked him if there was any particular thing that gave trouble in working the machine or in point of equipment. His advice was: "See that the bottom board bears right, and when you roll over the part of flask have a couple of wedges handy. Sometimes when the bottom board is warped and the part of mold is rolled over, it does not bear evenly on the supports, but on two corners (ends of cleats), in which case it gives trouble. Give your patterns all the draft you can, as any working of the guide posts of the machine or other parts will be multiplied at the far side of the patterns, and may give trouble as the parts wear. Don't use much oil. The fine dust in a foundry and oil are just as good as emery for causing trouble."

One point that commends the roll-over machine to the small foundry man is its adaptability to cover quite a field at comparatively small expense, in patterns and equipment.

Molding Machines in General

In looking over molding machines I find: The deeper the pattern the larger and more intricate the machine. A machine is profitable on which the pattern is rammed up by hand in the flask and drawn down through a stripping plate, where output will warrant equipment; the shallower and plainer the pattern, the less trouble to mold, if pressed up on a machine using compressed air or hand power.

In using the first, the molder is needed more particularly, not for patching the molds on account of their being broken in drawing the pattern, as the pattern can be made to leave the mold in perfect condition, but because of his general knowledge of how the mold should be constructed, of how hard it should be rammed in certain parts to withstand the strain, and how soft in other parts to allow the iron to lie to the sand, of how and where it should be vented, of securing here and there.

Molders are more observant than many employers give them credit for being: they watch each other closely and profit by their own and each other's mistakes.

Improving the Machine

It is for these very reasons that I believe the quicker the molder lends a hand to the improvement of the machine and his output on it, the quicker it will be for his advantage. For it is his knowledge and insight that is needed to help the machine produce the work successfully. Each style of machine is best adapted to some particular style of work; the machine on which everything can be made is usually found to fail, as on some class of castings.

The location of the foundry has been found to have much to do with the production of castings on the machine, it is claimed. This shows that the output of the machine in good castings is to a certain extent in the hands of the operator.

When there is put on the market a molding machine that will finish mixing and tempering the sand, supply it to the machine, press or ram it, and push out the molds, it will still be found that there is someone needed to set the cores, close the mold together and secure it for pouring. The molding machine in the future will be looked on differently from what it is today. As competition has improved other lines of machinery in the past, so it will do with molding machinery; with equipment for handling flasks and the melted iron, and in the future the machine molder will take a higher place in foundry practice.

Extensive improvements are to be made at the port of Dover, the nearest port in England to the coast of France. It is proposed to construct a new triangular pier 1500 feet at the base and 400 feet at the apex. When the works are completed Dover hopes to be able to compete successfully with Southampton, Plymouth, and Liverpool for the trans-Atlantic traffic. The time occupied in traveling by railway from Dover to London is now about 105 minutes.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Obtaining Machinists under False Prentenses

I am afraid Frank C. Hudson has been a little too ready to jump at conclusions, on page 422. I admit that the wage ($80) is high, higher than I have so far received, but I have still 30 years to go to the "bowed, gray-headed, efficient" age and may yet land an $80 job.

After a thorough investigation I find that the statements made by the *Tribune* are true. The Hot Air Drill Company put me on the track of these high-paid men and while I am not at liberty to men-

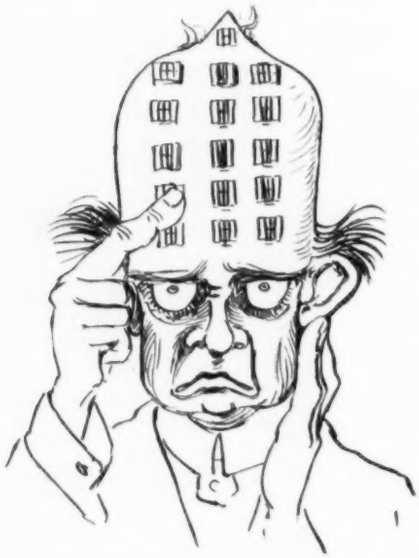


FIG. 1. AN IMPRESSIONIST PICTURE OF MR. BLANK

tion any names, I can give the outline of the most wonderful cost-reducing, wage-increasing system ever devised. Within 10 hours' run of New York, surrounded by beautiful grounds, is to be found the factory of the Blank Manufacturing Company, makers of timeless time locks. General Manager Blank is a man of probably 35 years of age, of striking appearance. Seeing him for the first time, one is overwhelmed with wonder that such a small body can support such a head. Pivoted on his shoulders like one of those gigantic rocking stones one sees pictures of, is an enormous five-story-and-attic brain box. As he spoke to me he sat at his flat-top desk, with his titanic head leaning on his left hand while the index finger of his right hand rested lightly on his massive forehead, thus suggesting an excellent imitation of a man thinking.

"You must understand that this system is indirectly the outcome of my studies of

FIG. 2. FRONT VIEW OF $80 MAN

Darwin, Huxley, Tyndall and Haeckel at college. You are probably familiar with what they say on the subject of natural selection, how the strong mate with the strong and beget a strong race and so on. That is 'natural selection;' *my* system I at first termed '*super*natural selection', but, lest scoffers might hint that I was in league with the powers of darkness, I have since modified the name and I now style it 'unnatural selection.'

"The principle of unnatural selection is to select the men not only on account of their mechanical training, but also because of their physical fitness for the work they are to perform. Thus, to run punch presses we select men who are without hands, either by accident or birth. These we supply (during working hours only) with good, serviceable artificial hands. In this way we avoid paying damages, for if

FIG. 3. SIDE AND REAR ELEVATION OF $80 MEN

a man gets an artificial finger or hand nipped off in a press it's the company's hand that suffers. These handless handy men are unable to find employment outside of our shops and consequently we can get them at our own price, while at the same time we pay them wages they could not earn elsewhere.

"The idea first occurred to me while I was foreman of the assembling department. In this work, which I will show you later, the men sit at benches and have to stoop over. It occurred to me one day that 500 assemblers (our usual force) wasting say five minutes (and that is a very small estimate) a day, in the actual acts of straightening up in their seats and stooping over into working position again, were losing 41 hours that ought to be saved.

FIG. 4. A SLIDING FIT

"That night a brilliant idea struck me; next day I advertised and the day after I had 10 hunchbacks, who couldn't straighten up if they wanted to, working at the assembling benches.

"With these as a start it was not long before I had all the old men replaced by men afflicted with curvature of the spine, though why it should be called an 'affliction' I cannot understand, for in this factory it's a positive boon to be some sort of a cripple, the only physically normal men being the two handy men who oil the shafting and even these were chosen because of their abnormal height and reach; they readily oil bearings 9 feet from the floor.

"But to get back to my special pride, the assembling room. Among the hunchbacks I had working under me was a man afflicted (how I detest that word) with strabismus, you understand what I mean,

cock-eye, you know. This man could watch me with one eye and attend to his work with the other. It was wonderful. Ah, how I have envied that man the spasms he had as an infant, which stretched those muscles.

"I called him into the office one day and told him that while I admired and envied his ability to watch me and attend to his work at one and the same time, it would be possible for him to earn double

FIG. 5. SCENE IN THE BOR(E)ING DEPARTMENT

wages by keeping his idle eye on another lock and assemble two locks at once.

"He told me he tried to do so many times, but was handicapped by not being ambidextrous. This hint dropped so innocently lost him his job and perfected my system. I advertised. Oh, yes, I am a great believer in advertising and also in lists. What! don't know what I mean by lists? Don't you know you can buy lists at so much a name? Hunchbacks, bald-headed people, cripples, wild-cat oil-stock buyers, etc., etc., anything, anything. I advertised for ambidextrous, cross-eyed hunchbacks, and I have cornered the market.

"My 250 cross-eyed, hunchbacked, ambidextrous assemblers take up just *half* the space that my 500 sound men used to do; they turn out more work, earn on an average double pay, while we sell locks now for less money and make bigger profits than we used to. Oh, yes, we are still developing 'unnatural selection' in other departments where it has not reached the perfection that it has in the assembling room: we have dentists in the gear-cutting department. No, while it is true, as you say, that babies cut teeth at a very early age we have yet to discover a way to utilize this phenomenon. In the drilling department we have discharged soldiers. Oh, yes, they *soldier*, too, but not with us. My brother has three epileptics in the grinding department, endeavoring to obtain accurate fits by new and original means. One is working on a greased floor where the sliding fits are developed. We are filling our boring department with men eminently suited for the work."

Mr. Blank then took me through the works. Fig. 1 shows an "impressionist" portrait of Mr. Blank, which I made of him while he was telling me of "unnatural selection." Fig. 2 shows front view, and Fig. 3, side and rear elevations of high-priced, cock-eyed, ambidextrous, hunchback assemblers in action. These are the $80 men referred to in the *Tribune*, which called forth the article by Mr. Hudson. Fig. 4 shows the production of a sliding fit. Fig. 5 shows an "eminently suitable man" in the *bor(e)*ing department.

DIXIE.

The Evolution of a Tapping Operation

The three sketches shown represent the jigmakers' efforts to find a quick and satisfactory way to tap the zinc nut which is shown full size. The nuts were to be made in large quantities.

The first attempt was by means of a spring chuck in the tapping fixture, Fig. 1, which was used on a vertical-spindle tapping machine. A spring knock-out, not shown, was used for ejecting the nut. This method was very slow, and the chuck gave much trouble by clogging with chips.

As some more productive way became necessary, it was decided to utilize an old Fox lathe for the purpose, and the device in Fig. 2, was made. This is a spring chuck of special shape, provided with a

FIG. 1

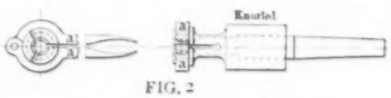


FIG. 2

THE UNSUCCESSFUL METHODS

taper shank to fit tail spindle and closed upon the work by means of the hinged handles *a a*. The tap was made with the shank as long as the lathe would accommodate, the end of the shank milled with three V-shaped grooves for about an inch and held securely by a turn of the hand in a No. 2 Almond drill chuck in the live spindle, the chuck jaws fitting into the grooves in the tap shank.

After the tail spindle had been relieved of its screw feed so as to slide freely, the operation was as follows: With the left hand in position to close chuck, the right hand picks up and inserts a nut and then grips the nurled end of the chuck and pushes ahead until the tap passes through the nut, when the chuck is released and returned to the first position by both hands, the nut remaining on the shank of the tap, after which the right hand is free to begin again. The tapping is continued until the tap shank is full, when the lathe is stopped and the nuts slipped off the shank into the box.

It was this necessity of using both hands for tapping and reversing that caused this method to be abandoned and the fixture, Fig. 3, designed. There were other defects also, such as the chuck filling up with chips, which were not easy to remove, and the necessity of having a good left hand that would not tire with the constant gripping of the handles.

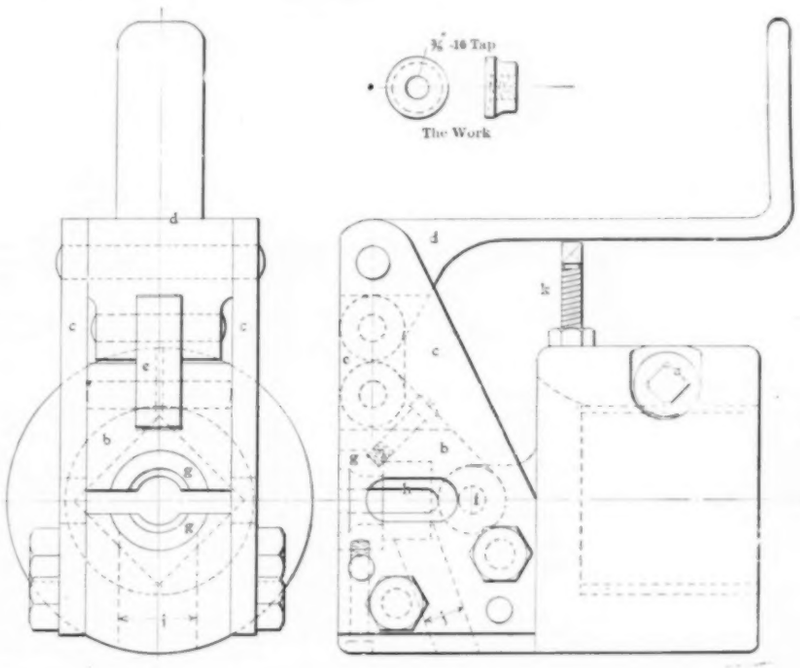


FIG. 3. THE SUCCESSFUL FIXTURE

The tail spindle of the lathe was of square section, so that the last fixture was made to clamp upon the end of the spindle. The body of this fixture was of machine steel, and to avoid the labor of sinking a square hole in the end of it, a hole was bored somewhat larger than the

diagonal of the square. Next, two pieces of steel were roughly shaped to semi-circular section, and a 90-degree V planed in the flat side, and then clamped onto the spindle and the outside turned to fit the bore of the fixture, which was split and clamped to the spindle by the screw *a*.

The front part of the body was planed away, as shown in the sketch, and fitted with the hinged piece *b*, side plates *c c*, lever *d* and link *e*, so that raising the lever would swing up the piece *b* on its hinge pin *f* and open up in front.

After being fitted properly, the whole was placed in its future working position and centered by the tool in the head-stock and afterward chucked in the lathe, trued up by this center, and bored by the split bushing *g*, also bored out in the rear of the bushing for clearance. The bushing *g* is hardened and any form of small nut may be tapped in the fixture by making the bushing to suit, the two halves being held in by screws. The side plates are cut away as at *h*, and the oblong hole *j* is also worked out to allow the chips an easy egress. The stop *k* prevents the link from passing over the center.

In operation the right hand remains holding the upturned end of lever *d*, the lever is raised, a nut inserted by the left hand, the lever is pressed down, clamping the nut, and the fixture is pushed ahead by the right hand, which, as soon as the nut is tapped, raises the lever and draws back the fixture for another nut.

The same tap was used with No. 2 and No. 3 fixtures, so that each hand performs a separate function instead of both being required, as with the methods 1 and 2. Another gain is that a handful of nuts may be picked up by the left hand and one selected by thumb and finger ready to insert, while the tapping and reversing is being done by the right. By the previous methods each nut must be picked up singly, during which time the machine and other hand were idle.

As the same small boy operated each of these fixtures in turn, his output may be taken to indicate the merit of each method. With the first fixture the best day's work was about 12 gross in 10 hours; with the second, about 20 gross; and with the last one, about 43 gross.

The same price obtained with first and second fixtures, while with No. 3 it was reduced 40 per cent. per gross.

RAYMOND GRANT.

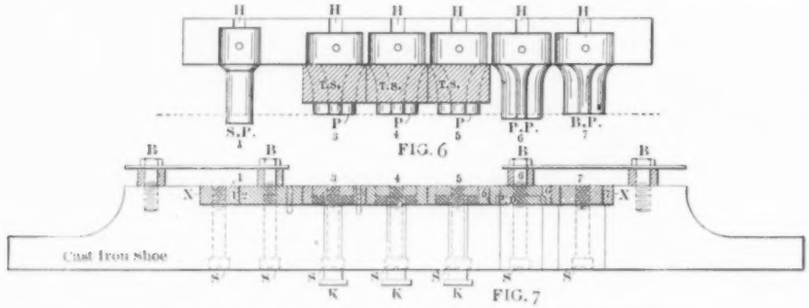


FIG. 8

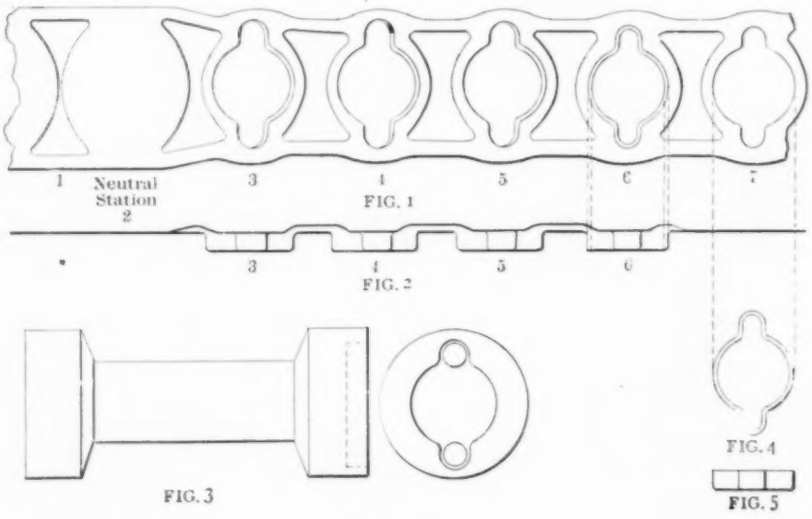
THE GANG PUNCH AND DIE

Referring to Figs. 6, 7 and 8 you will notice the construction of the die and punches. Fig. 8 is a plan of the gang die; Fig. 7 is a side elevation of the die, and Fig. 6 is a side view of the gang of punches. In using this die, the steel ribbon was fed to the die from the left. There are no pilots or stops on this die. The steel was fed to the die by means of a very accurate automatic-roller friction-feed mechanism. Before building the die it was necessary to do some experimenting. After concluding my experiments I was in possession of the following data:

I knew that before operation 3, Fig. 1, the stock must be slitted on either side, as in the neutral station 2, thus giving the stock ample opportunity to be drawn into the die without undue resistance. I also knew then what the distance should be from the center of one station to the center of the next.

It will be noticed, on referring to Figs. 7 and 8, that the die proper, instead of being made in one piece with the several operations thereon, is composed of several pieces of tool steel all accurately fitted together and securely held endwise by being recessed into the die shoe, as shown at *X*, Fig. 7. These pieces of tool steel were laid out separately, screw holes drilled and tapped, also dowel-pin holes drilled. Then the pieces were machined and finished. Before hardening and tempering, the center lines, both crosswise and lengthwise, were delicately prick-punched, so that they could be located after tempering.

When planing the blanks, they were left wider than finished size to allow for contraction in hardening, also for grinding to proper width. After tempering, the several pieces were ground on the edges until they were the proper width, also each edge equidistant from the center line. Having ground each plate to proper width, it was only necessary to make the recess in the die shoe to fit the complete length of all the parts assembled. After assembling and proving the measurements



THE WORK

A Gang Die for Making a Ferrule

The product required is called a ferrule. Figs. 4 and 5 show the plan and elevation of the ferrule, and Fig. 3 shows it driven, sharp edge first, into the wooden spool or bobbin. The end wings form receptacles for drivers, by which the bobbin or spool is turned. In Figs. 1 and 2 are shown the ribbon of drawing steel and the several operations as they progress from the first to the last station of the gang die.

from the center of one plate to the center of the next plate, and so on throughout the seven stations, it was only necessary now to drill through the several screw and dowel-pin holes, already in the tempered plates, into the cast-iron die shoe, using the tempered plates as jigs. Having all the holes in the die shoe, the tempered plates were removed and the holes in the shoe finished. The holes were also cut through the shoe to allow escape for the scrap from the stations 1, 6 and 7. After finishing all the holes in the shoe, the die plates were replaced. All the binding screws and dowel pins were put in place and the die was finished.

The gang of punches came next. The holes for receiving the several punch shanks having been accurately located, the holes were indicated and bored in the lathe. The punch blanks having been turned to fit the holes in the holder, the faces of punches 3, 4 and 5, Fig. 6, were accurately layed out to the shape of their several dies, also to the size of die minus double thickness of the ribbon steel. The punches were then milled to size and shape in the dividing head of the milling machine. Plate 6, Fig. 7, is recessed up from the bottom side. A thin die *P D*, Fig. 7, is inserted. This die is for punching out the bottom of form 6, Fig. 2.

The next operation, at station 7, blanks out the complete ferrule, open top and bottom, as shown in Figs. 4 and 5. The punch marked *S P* is the slitting punch which works in station 1, Fig. 8. The punches marked *P* are the two drawing punches 3 and 4, and the stamping punch 5. The punch marked *P P* is the piercing punch, which punches out the bottom of the form, and *B P* is the blanking punch, which punches out the finished ferrule. The ferrule then drops through the die and shoe. False bottom plates are fitted into the stations 3, 4 and 5. Pins *K K K*, Fig. 7, passing through the shoe from below, are tapped into these plates. These false plates serve as bottom striking plates and also as knockouts. Referring to Fig. 6, *H H*, etc., are drift holes and the plates marked *T S* are strike plates.

G. H. WARD.

Mistakes Due to the Abbreviated Drawing of Screw Threads

Referring to recent articles on the reduction of drawing-room work, Fig. 1 shows the drawing of a screw, the thread being shown by two double rows of dotted lines.

This method was followed by a draftsman and, after the work was completed, the piece of work was sent to the drawing room to be modified to suit new work.

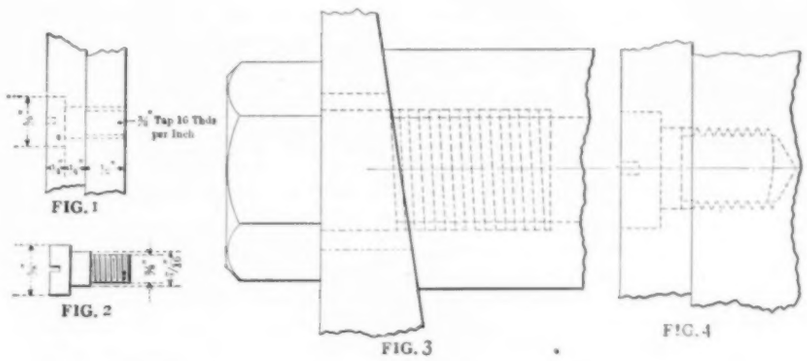


FIG. 1

FIG. 2

FIG. 3

FIG. 4

THE RIGHT AND THE WRONG WAY OF SHOWING SCREW THREADS

When the screw was removed it was found to be made as shown in Fig. 2.

Fig. 3 shows the drawing of a bolt made on the same lines, that is, with the double rows of dotted lines with additional lines showing the direction of the threads. When the machine came to be assembled, it was found that square threads had been cut on the bolts.

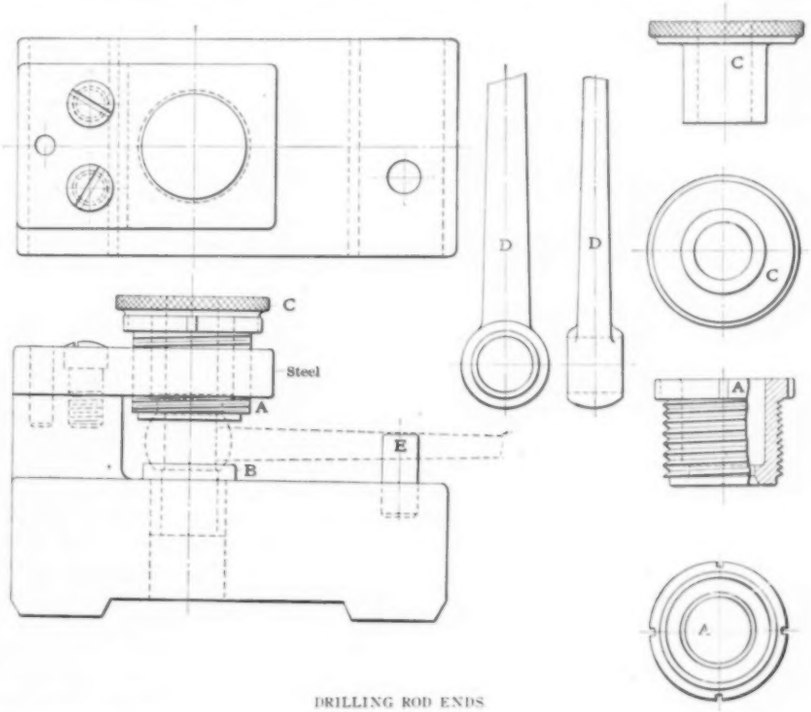
The correct method of representing screw threads is shown in Fig. 2, and when necessary to show threads dotted they should be represented as in Fig. 4.

Fitting a Hardened and Threaded Plug

In making a jig a short time ago, I needed a hardened and threaded plug to fit a hole that was tapped 2½-inch 14 thread. In making the plug, I allowed three-thousandths of an inch for swelling of the steel in hardening, as that seemed to be about the amount that that particular brand of steel needed. Nevertheless, after hardening, I found that the plug couldn't be persuaded to go into the tapped hole. Not having a larger tap, I took a piece of three-quarter square brass and put it in my tool post and, using the 2½, fourteen-thread tap as a hob, made a brass lap in the form of a chaser. Then I put the hardened plug between centers and, using a little flour of emery on my brass piece, quickly reduced the plug to the proper size. The brass lap, being the same pitch as the plug, finished the threads smoothly and evenly and made a fit that couldn't be bettered. E. V.

Drilling Rod Ends

For drilling and reaming bosses on levers the arrangement herewith shown has proved very satisfactory. The piece *D* is held between bushings *A* and *B* recessed to fit. Bushing *A* is threaded and with a spanner wrench is screwed down to hold the work in place; it also receives the bushing *C*, which is removed after drilling, permitting the reamer to pass in freely. A pin *E* in the



DRILLING ROD ENDS

cast-iron base prevents the work from swinging around. GERALD.

A Tool-buying Club

Seeing some men continually borrowing others' tools in our tool room aroused the attention of J. Selander, the tool-room foreman. Being a man of good inventive ability, he proved himself equal to solving this problem by organizing the Empire Tool Club, this happening in the shops of the Empire Cream Separator Company.

He saw by studying the men that they would make good mechanics if they had the proper tools to work with; but all men are not good savers, so one afternoon he suggested the club to the "boys." The idea was heartily accepted and needed no second motion to set it going. Twelve men immediately placed themselves on the list as members. Each member that joins pays in 50 cents per week, and 12 slips were numbered from 1 up and put in a hat. Then each member drew and the man drawing No. 1 got the money the first Saturday, it being arranged so that each week some member gets the whole amount, in this case $6. No. 2 gets his the following Saturday, and so on until the series runs out. Then a new lot of slips is made and another drawing made.

Each member binds himself when he joins, by signing the rules of the club, to use the money for the purchase of tools only. Should a member "get through" before he is benefited, he has the choice of paying the balance to get his selection or to withdraw what is due him. If he has already benefited but has not paid up fully, he must either pay up or give up his tools and withdraw what he has paid.

This scheme enables men to buy micrometers or pretty expensive tools without realizing the cost by paying the whole amount at once. The firm likewise is benefited, because the men, having their own tools, do not have to borrow from others, thereby wasting the company's good time.

This scheme appealed to me so strongly that I thought other readers of the AMERICAN MACHINIST might be interested. CARL ARMERDING.

Fly-wheel Joints

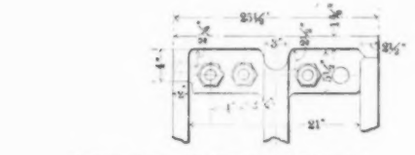
Two weeks ago there was an interesting article in the AMERICAN MACHINIST on the strength of fly-wheel joints. You exhibited a design which, with square-rim or approximately square-rimmed wheels, is very efficient.

Unfortunately, this does not solve the problem, as the wheels that give the most trouble and are most dangerous are the wide-face but thin-rimmed belt fly-wheels.

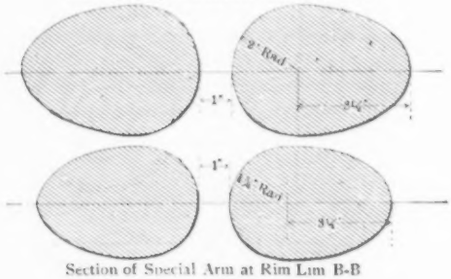
The thin rim is of itself a source of danger, as it has no strength to resist the lateral pull of the arms. When a joint is placed midway between two arms in a split wheel it greatly increases the danger of rupture. If a joint could be designed for these wheels as efficient as that described by you, it would meet a long-felt want.

It has been our practice the last two years on wheels of this type to use double arms at the joint, as shown in illustration. This eliminates a good deal of the difficulty with wide-face wheels, but does not overcome it entirely. When wheels have exceedingly wide face we make two wheels and bolt them together, breaking joints. J. B. STANWOOD,

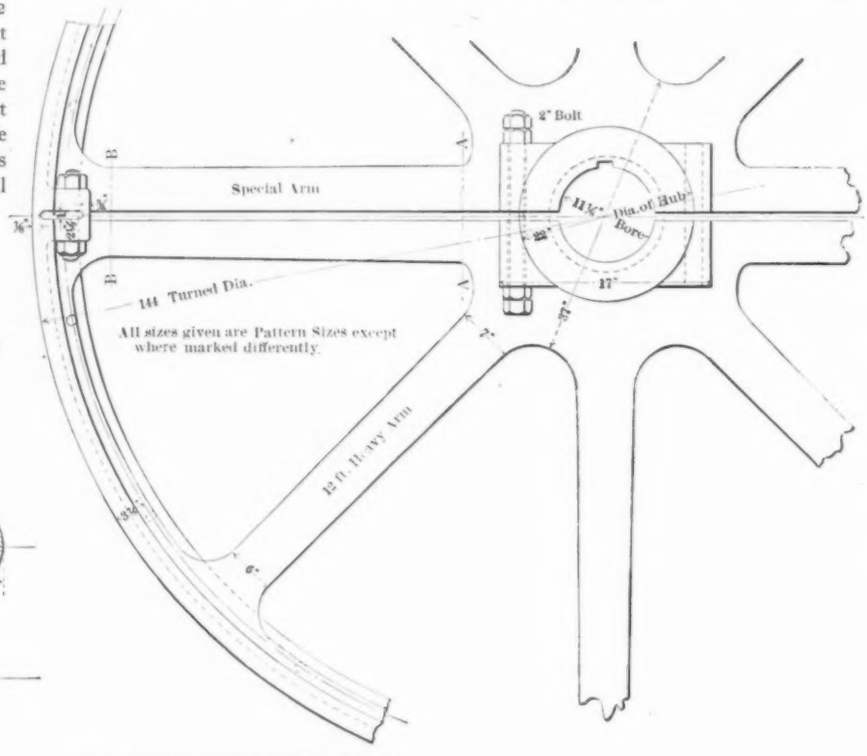
Vice-president and Engineer of the Houston, Stanwood & Gamble Company.



Section of Special Arm at Hub Line A-A



Section of Special Arm at Rim Line B-B



DOUBLE ARMS AT FLY-WHEEL JOINT

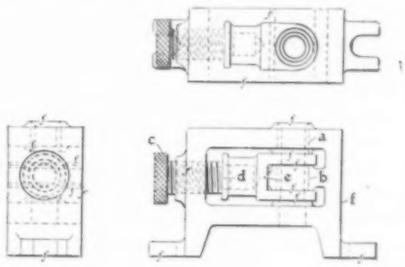
Lubricant for Screw-machine Work

In mixing soap water for a lot of automatic screw machines using soft machine steel for making bicycle cones and nuts, a few years ago, I had trouble with the mixture caking up and clogging the pipes; and where a pipe feeding water on to a tool clogged, it meant a burnt forming tool and a lot of extra grinding. The cutting preparation that was bought was as bad as our own, and I began experimenting. Now it had been the practice in fixing up our soap water to take a bucket of lard oil, add about half a can of potash, boil it and then put it in the tank and add water till it looked right and felt slippery, like wet borax. After considerable trouble I hit upon the right mixture. The formula is as follows: To each barrel of water, add two buckets of lard oil and one can of Babbitt's lye (potash); put it in the tank *cold* and let the pump do the mixing. The result is a creamy colored and feeling mixture that keeps the tools cool and clean and does not cake or clog pipes or pump. When the soap water begins to look thin and watery or feel gritty, add a bucket of lard oil and half a can of the lye; and if it isn't all right in an hour, add some more. If it gets too thick, add cold water (never hot under any circumstances) and you'll never have trouble with clogged pipes. I ran this mixture for two years in pipes that were really too small, but which the management refused to change, and never had one clog after I began using it.

E. V.

A Drill Jig for Knuckle Joints

That English drill jig for knuckle joints described at page 286 is rather expensive for such simple work. If I had that piece to make I should finish the bottom of the fork to an even depth, and then use the surface *e* (see drawing) in my jig for location one way, and the



THE JIG

end of the screw the other way, acting on surface *d* pressing against surface *e*.

The English jig body is composed of five parts, two nurled screws, and six fillister-head screws, or 13 parts—just the unlucky number. My jig, which is according to American practice, is in one single piece, finished as marked, and I have one screw *c*, and two bushings, *a* and *b*, or four pieces all told.

I am sure that this design of jig will be considerably cheaper, just as easy to keep clean, and will do as accurate work as can be wished for. GUTTA GITTA.

A Small Eccentric Boring Tool

Here is a small eccentric boring tool to enlarge or "chamber" a hole at any

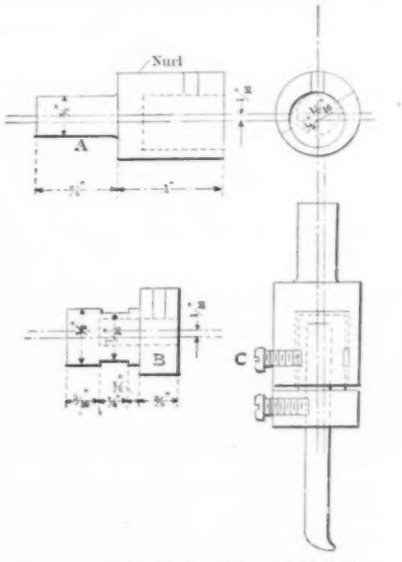


FIG. 1. SMALL ECCENTRIC BORING TOOL

distance in from the surface. This is for small work which must be accurate, as in jig work.

As will be seen the tool holder *B* is bored 1/16 inch out of center with the outside so that half a turn gives it a throw of ⅛ inch. It can be turned to the desired point and locked by the set screw *C*. All dimensions are shown and it has been found very handy in our work.

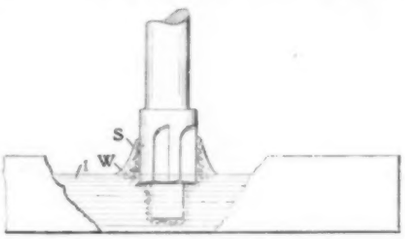
JAMES BENNETT.

Hardening a Counterbore

It has been well said that "good theory is good practice." As a further illustration, if one were needed, of the truth of the assertion, the following might serve; it may also "help somebody some time somewhere."

In a certain factory where a large number of counterbores were used, so many were regularly broken that it became not only a nuisance but a serious matter of expense. When the junior partner came back from the university he met the problem and conquered it; whether he had been taught to "think correctly" would be hard to say, but in this case he reasoned from cause to effect.

He reasoned that the pilot and the body of the counterbore should be hard for a distance equal to about one-eighth of an inch, measured lengthwise from the cut



HARDENING A COUNTERBORE

ting edge, and all the rest soft; but how to get the dividing line between the hard and soft portions as narrow as possible was a problem.

He evolved a theory in hardening.

In the illustration is shown a shallow pan having the front side partly broken away to show the water and a counterbore being quenched, the water line being indicated at *l*. The first contact of the steel and water chills the cutting edges to a hight about equal to the distance they extend into the water, while the higher portions of the steel are cooled by the radiation of the heat into the cooler lower portions, and by the contact with the water *w* which rises and surrounds them, and the still higher portions probably in a lesser degree by the rising steam indicated at *s*.

Of course, the action is the same as though the steel were immersed an equal distance into a larger body of water, except that the radiation would be quicker and water cracks due to strain would be more likely to appear.

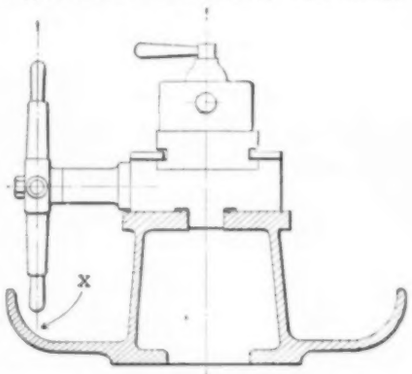
After hardening, the temper was drawn of course.

I have frequently tried this method on pieces other than counterbores with invariably good success.

A. B. CHRISTMAN.

Pilot Wheel with Telescopic Arms

I recently had a quantity of heavy drilling to do on a hand turret lathe without



SECTION THROUGH BED OF LATHE

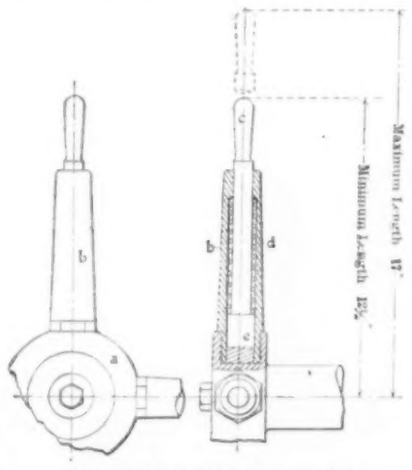
power feed, and found that if I could have longer arms on the pilot wheel, I could get a better leverage, use high-speed steel drills, and take a pretty heavy cut. On examination I found that, owing to the small space between the end of the arms and the tray (shown at *X*, Fig. 1), I could not fit longer arms without some alteration.

Of course, I could have overcome this difficulty by extending the pilot-wheel out till the arms cleared the outside of the end tray, but the idea of telescopic arms occurred to me, and I thought they would look better than the long, solid arms; also they would not be so much in the way.

Fig. 1 is a section of the bed, showing the telescopic arms in their normal position.

How They Were Made

Fig. 2 shows the construction of one arm, all four being made in the same man



HOW PILOT WHEEL WAS MADE

ner. *A* is the hub of the wheel, *b* is a cast-iron sleeve, turned and drilled to carry the steel arm *c*. The spring *d* keeps the arm pulled toward the center, and is only just strong enough to hold it in against its own weight when hanging ver-

tically downward. The plug *e* is driven in merely to keep the arm in the sleeve when assembling.

It requires very little effort with one hand to lift or pull the arm out, and the pressure put on for drilling keeps it out until released, when, of course, it immediately springs back to original position.

CONRAD.

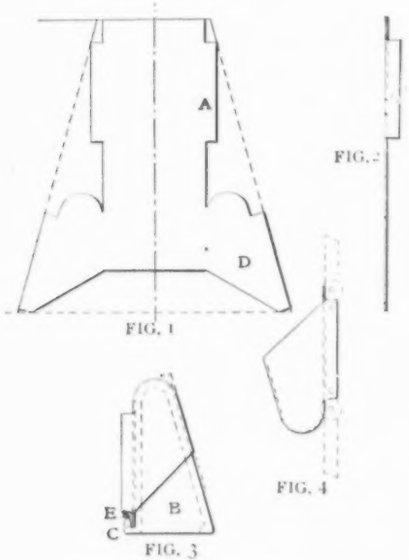
Making an Elevator Bucket without Rivets and in One Piece

While this style of engineering is not quite in your line, I send you this, feeling sure that it will interest some of your readers.

Fig. 1 gives a plan of plate for first operation, so that it will be seen that this process is an economical one, very little metal being wasted. The pattern is laid on the plate, and then the plate cut out.

The first portions to be bent are the flanges *A*. These are to be bent as shown in Fig. 2. For the next process, it is needful, though not imperative, to have a cast block *B* the same shape as the inside of the bucket, with a small slot cast as shown in Fig. 3 at *C*.

Next, heat plate across the body, drop



MAKING AN ELEVATOR BUCKET

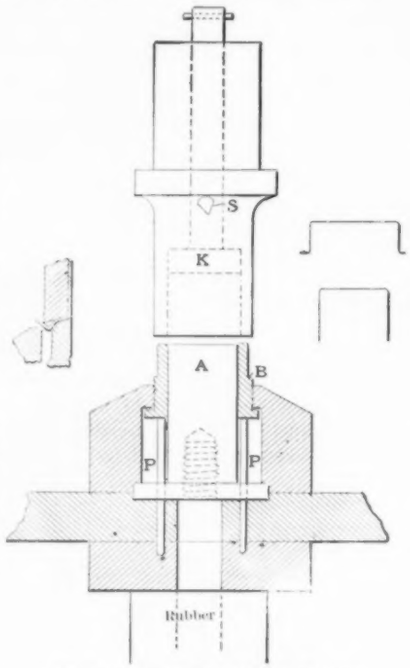
the narrow end into the slot at *C*, with the flanges outward, insert wedge *E*, and then pull over the block. Afterward heat the two wings *D* separately, and pull round the block. The dotted lines in Fig. 3 show wings prior to this process. All that is now needed to complete the bucket are the bolts for fixing to chain. These bolts serve the double purpose of fixing to chain and holding the bucket together. The assembled arrangement is shown in Fig. 4.

BLACKSMITH.

Manchester, England.

A Drawing and Trimming Punch and Die

The punch and die combination here shown will serve to illustrate a redrawing and trimming operation not as well known as it merits. It produces true straight work and eliminates the trimming operation, which is usually slow and cost-



DRAWING AND TRIMMING PUNCH

ly. The construction is of the usual single-action type, the drawing block *A* being set quite high relative to the trimming die. The body of the pressure ring *B* is large enough to fill the die and prevent stripped tin, dirt, scrap, etc., from dropping inside; and the upper part fits the cup to be reduced, which is shown in outline. The drawing edge of the ring is made tangent to about a 15-degree bevel, and is very useful for two purposes in this case. The punch is quite ordinary, fitted with a knock-out *K* and scrap cutters, *S*. The mouth is beveled to fit the ring and both are lapped together with flour emery. The outside diameter is given a few thousandths clearance to save the die from excessive wear, and the inside is similarly cleared a thousandth or so to reduce friction.

How It Works

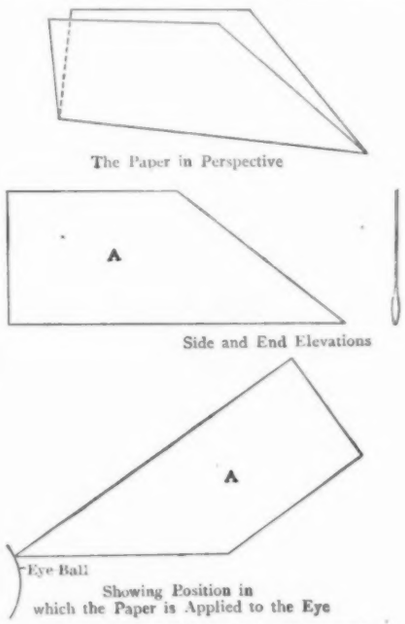
A chute and disappearing fingers place a flanged cup over the ring at each stroke of the press. As the punch descends, the body of the cup is reduced in diameter and then at a certain point, when the corner of the cup begins to climb the wire edge of the ring and the strain of drawing is much reduced, the cut edges act and trim the flanges. During this short interval, a small amount of stock composing the corner of the cup is filling out the bevel of the punch, permitting it to descend sufficiently to trim without tearing the cup. After trimming, the two bevel surfaces hold the flange while being drawn into the body, preventing wrinkles. If the cutting edge operates too soon, i.e., is too high, the cup is jammed down between the die and ring, the flange being bent so as to prevent trimming; and if too late, or low, the flange has begun to draw in and the trimming holds the stock long enough to burst the head of the cup.

About the proper time is indicated in the side show sketch. A difference of 1/64 inch will make or break a cup, so once the hight is found it must be maintained, and this is also true of the depth of the first cups. A soft-rubber barrel is used below the pin plate for pressure, small in diameter but quite long, and stiff enough to prevent wrinkles as the flange draws in.

SIRIUS.

An Inexpensive "Instrument" for the Shop Eye Doctor

As a safe and efficient means of removing any foreign substance from the eye, I submit by permission a scheme successfully used by our shop eye doctor, viz.: a piece of letter paper is folded and cut with a sharp knife to an angle of about 30 degrees, as shown by the sketch.



A PAPER INSTRUMENT FOR REMOVING FOREIGN BODIES FROM THE EYE

The folded paper is then held between the fore finger and the thumb at *A*; the point is pressed on the back of the thumb nail, which leaves the paper in the shape as shown in end view in the sketch. The point of the paper is then slightly moistened on the end of the patient's tongue. Then that part which is cut at an angle is held at right angles to the surface of the eye and brought straight down over the eyeball until it comes in contact with the substance in the eye, which it invariably moves at the first trial.

JACKSON.

Commercial Value of Industrial Schools

Discussion of Methods for Establishing and Managing Trade Schools That Shall Be a Practical Aid in the Manufacturing Industries

BY SAMUEL F. HUBBARD

There was a time when the commercial value of industrial education was on trial, whether or not it could contribute anything to the scientific knowledge and industrial training required in the productive industries beyond that which could be acquired in the shop. There is still an echo of the old assertion, "The only place to learn a trade is in the shop."

Germany, poor in natural resources but rich in her thousands of trade schools, whereby goods labeled "Made in Germany" are found in every port, is the classical example adduced to show that special industrial schools have a distinct economic value.

Nobody who has given more than a passing thought to it, denies that industrial education does have a positive commercial value. Since I am limited to twenty minutes in this paper, it seems to me better not to try to demonstrate this statement, but to devote the time at my disposal to a consideration of certain aspects of industrial education by which the commercial value can be secured.

The fact that this question is put on your program is an evidence of your interest in industrial education and, because of this, I feel that I may safely leave out much that otherwise ought to be said.

Establishing Trade Schools

The paramount question in industrial education today is not as to its value in contributing trained intelligence to the protective industries but how, in what way, shall trade schools be established.

Several ways suggest themselves. They may be started:

(1) By the State working in conjunction with municipalities.

(2) By the State co-öperating with employers, either singly or collectively.

(3) By philanthropists.

(4) By employers themselves.

The first method here suggested has been accepted by Massachusetts. Two years ago, a temporary commission was appointed by act of the Legislature to report on industrial education. On the basis of that report it was enacted that the Governor should appoint five persons to serve as a commission on industrial and technical education with power to establish trade schools under certain conditions. By this act the State definitely recognizes that industrial education, by means of trade schools, is as legitimately a part of the public school system as the education given by the grammar or high school. Indeed, admitting the fundamental principles on which our common schools are based, it is difficult to show why this is not a logical sequence.

*Read at the Boston convention of the National Metal Trades Association.

A Better Way

A second method of establishing trade schools is by the State coöperating with employers, either singly or collectively. In my judgment the Massachusetts law would have been much more effective if the commission had been allowed to deal directly with the manufacturers rather than through the municipal authorities.

The trade-school idea is a matter of education. It can never be made efficient without the enthusiastic coöperation of all concerned. The inertia of indifference to trade schools on the part of employers must be overcome by showing them their value.

A trade-school propaganda is necessary, as it is useless to provide anything, however beneficent, if nobody wants it. A State commission, by virtue of its larger opportunity for knowledge, can be that propaganda, and can stimulate, advise, suggest and give material asistance to those who must ever be an important factor in the conduct of any trade school, namely, the employer.

Sharing the Expense

To make it necessary that the municipal council shall be educated up to the point of voting funds for the establishment of trade schools, with all the difficulties attendant upon such education, before anything can be done, is, I believe, to unduly hamper the commission in their work, especially when public-spirited manufacturers stand ready to share with the State the expense of such schools, and to assume the lion's share of the responsibilities involved in their administration.

Another method of establishing trade schools is by private philanthropy. This is easy, so far as the financial end is concerned, if one can get the philanthropist. It is assumed that all trade schools started by such methods will require the coöperation and help of the best representative employers of the several trades taught. Boston is anticipating the establishment of a trade school under the terms of a will, whereby several million dollars have been given for the purpose of trade training.

Employers Trade Schools

Again, trade schools may be organized by employers. Indeed, there are those who urge that they are the only proper persons to take the initiative in establishing and administering such schools, especially until such time as the State shall realize its obligation to share this service. The manufacturers know better than anyone else how important a factor industrial intelligence is in production, and they, above all others, are most competent to inaugurate a systematic method of trade training. The American manufacturers show a wonderful power of organization, are keen and alert to discover new processes and methods, do not hesitate to spend thousands upon improved machinery, and the marvel is that, with all this mental grasp and clearness of vision, they have not as yet demonstrated beyond question the economic possibilities of industrial education. I do not believe it is necessary for the manufacturers of the United States to wait until the State or the philanthropic angel steps in and troubles the waters before they may assume to take the initiative in the establishment of trade schools.

The American Plan

The problem of trade training is made more complex by the system of specialization in the means of production. This system has been carried so far with us that it is known as the "American plan." It is unquestionably true that even a limited intelligence can be focalized to a single process so that the output will be greater in quantity and better in quality than can be secured by distributing a higher intelligence over a wider range of processes.

Naturally, the time required to learn one process is much less than is needed to learn several, and a boy becomes a productive unit just that much sooner. The system of specialization seems to indicate that a relatively inferior boy can be so trained by this method that he may become a better economic investment for the employer than one trained by a system which aims to give a broader and more general instruction.

Imperiling the Future

No one denies the economic value of a highly specialized system of production, but is there not a danger that so much emphasis may be placed upon this method as to eliminate, so far as shop opportunity is concerned, the all-round workman in favor of the specialist, skilled in one thing, and thereby imperil the ultimate welfare of the productive industries?

There appeared recently an editorial in a leading trade paper on "Specializing in Apprenticeships." It indicated that the large machine shops of this country are beginning to carry the idea of specialization even to apprenticeships; that by this method the amount of training needed by workmen could be reduced to the lowest terms with direct advantage to the employer. In order to get a comprehensive idea of the effect of such a system on the productive industries, a copy of the editorial, together with half a dozen questions, was sent to several large manufacturers in the metal trades.

All-round Men Needed

Obviously it is impossible for me to give more than a hint as to the nature of the replies. All were agreed that beginners from 16 to 20 years of age should not specialize narrowly in learning a mechanical process. There was a unanimous opinion that a certain number of all-round workmen are needed in the manufacture of machine products, the approximate number varying from 10 to 50 per cent. of all employed. Some were positive that the system of high specialization is inconsistent with encouragement to aspiration on the part of bright men, others were equally emphatic in their dissent from this conclusion. I am inclined to think this difference of opinion is due to the different points of view. All were of the opinion that the demand for broadly trained workmen is increasing. I quote one reply in full:

"Perhaps there never has been a time in history when the value of a broad training to the workingman has been so keenly felt as at the present day. It has been proven by statistics that the countries that have provided most liberally for the training of the workingman, are making the most rapid advances in manufacturing. This training, we believe, should be given in properly equipped manual and trade schools, training the mind as well as the hand."

The response to the question whether specialization does or does not result in making of the workman an "animate tool" is practically summed up in one reply which I quote: "Any workman lacking ambition or energy can become any, if little, better than a machine operator."

A Broad Training Best

These replies point decisively to the conclusion that it is desirable that bright young men should have at the outset a broad industrial training; that a certain number of all-round workmen are needed in every industry and that the demand for such is increasing.

In view of the difficulty, which obtains in many shops, of giving this thorough, systematic training, the trade school seems imperative. It is held that a school properly equipped, having a well planned course of instruction, under the personal guidance of competent instructors can lay a better foundation for the future workman, and do it in a much shorter time than can be done in any other way. Such a school, in my opinion, should not be independent of the shop but supplementary to it. The school has its limitation in trade training as well as the shop, each is necessary to the other.

Prof. Hanus' Conclusions

In this connection let me note one or two conclusions which Professor Paul H. Hanus, chairman of the Massachusetts Commission on Industrial and Technical Education, has reached. I quote from a public address. After emphasizing the need of industrial schools to supplement the existing public schools, he says:

"Such schools would receive pupils 14 to 15 years of age who declare their intention to learn a trade, and would therefore be parallel to the existing high schools, but independent of them.

"Such schools must be independent schools because the motive and end for which they exist, namely, vocational training, as contrasted with the general training of the existing public schools, determines the value of the instruction in every detail.

"Such schools would offer a course of study covering four years. The first two years would comprise general shop instruction with related drawing, mathematics, natural science, the history of industry and commerce, shop and business English and the reading of appropriate articles and books.

"The last two years would give shop instruction for particular trades, and for each trade represented, the drawing, mathematics, physics, chemistry of that trade, the history of that trade, treated both as special history and as a branch of general history, civics treated as concretely as possible, and English as before."

This program suggests that industrial education may eventually cause radical changes in the academic methods which now obtain in our public schools, as well as a change in the attitude of the schoolmaster toward trades as a vocation.

What Emerson Said About It

Fifty years ago, Ralph Waldo Emerson charged popular education with a want of truth and nature. He complained that an education to do things was not given. He saw that literature, far from being the only factor in civilization, was not even the chief one. He said, "We are students of words! We are shut up in schools and colleges and recitation rooms from ten to fifteen years, and come out at last with a bag of wind, a memory of words and do not know a thing, we cannot use our hands, or legs, or our eyes or our arms."

It is a growing conviction, I believe, that this broad trade training is better assured by having an apprenticeship indenture than without it. Stripped of all legal phraseology an apprenticeship indenture is simply an agreement between two persons to perform certain acts which are of mutual advantage, that is, to teach and to be taught during a fixed time. The indenture guarantees to the boy an opportunity to learn his trade as a whole, or such part of it as may be agreed upon, a fixed wage and a steady increase during his term of apprenticeship; it guarantees to the employer continuous service on the part of the boy during a definite time, and a more faithful performance of his work because the boy realizes that his interests are bound up with his employer's.

Indentures Desirable

This arrangement seems so eminently desirable on the part of each, and so mutually beneficial that it is difficult to understand why the system of indentured apprenticeship is condemned in no unsparing terms, or relegated to the scrap-heap as obsolete. It should be said that these adverse criticisms come from people who know the least about it, and never from a thoughtful employer.

True, the employer may have personal reasons for not adopting the apprenticeship system, but it is not because he considers the system conducive to "slavery" or that it is "un-American." I believe a system of indentures will facilitate the work of a trade school.

It is with much satisfaction that I find this association is formally on record in saying, "A proper apprenticeship system is essential to the education and perpetuation of skilled mechanics."

Leakage in Valve Castings

The use of brass-melting furnaces in which the metal is poured out into a ladle and from this into the mold has brought about a difficulty which heretofore rarely existed. It is the leakage of the castings when they are tested. They usually leak in the same place, near the gate and, while they have every appearance of soundness, they will not stand the necessary testing pressure.

This difficulty is caused by too low a pouring temperature. The fact that the metal is poured from the furnace into a ladle and from this into the mold gives ample time for the metal to cool and, therefore, when it is poured into the mold it is not sufficiently hot. It is well known that hot metal is needed to make good steam metal valves and we have recently seen many examples of leakages in valves on account of too low a temperature having been used in pouring. Hot steam metal means the minimum number of leakages.—*The Brass World.*

It is said that British India takes practically half of the world's supply of silver.

Packing Machinery and Parts for Export

Suggestions That Will Save Freight Charges, Breakage and Annoying Delays by Custom-house Inspection to Manufacturers and Exporters

BY PAUL ROUX

All machine tools after having been completely assembled, inspected, and tested in practical running should be more or less completely dismounted before packing. It is impossible to lay down fixed rules in this regard, as the extent to which a tool should be dismounted varies with each machine, or rather with each class of machinery. The manufacturer must take into consideration the resistance of the tool and its various parts to rough handling in transportation, and decide upon what extent it should be dismounted to insure safety. It must be remembered that while the packing case will protect a machine against blows which it may receive when in a normal position it offers little protection against side or abnormal thrusts resulting from an overhanging position. Great care must therefore be taken to see that no part of the machine is in contact with the sides of the case that is not fully able to withstand the rough handling to which the case can be subjected. The feet of a lathe bed, the base of a shaper, or of a milling machine, may be readily broken by the packing case falling, even lightly, on one of its corners, and without the latter showing any external evidence of the fall.

Volume and Weight

A most important consideration to be taken into account when dismounting a machine is its volume when packed for shipment. Marine freights are generally reckoned at so much per ton weight, or per 40 cubic feet, at the option of the ship. The exporter has, therefore, every interest to see that the weight, which can not of course be varied, does not occupy a space greater than 40 cubic feet per ton. Nearly all machines, when not dismounted, make up into packages greatly exceeding 40 cubic feet per ton, and even under the best conditions can rarely be packed in cases equivalent in weight and volume. It may therefore be laid down as a general rule that every effort should be made to reduce the volume as much as possible by dismounting all projecting parts which increase the over-all dimensions of the packages. On the other hand, the difficulty of assembling parts requiring accurate adjustment must be taken into account, and the exporter must use his best judgment in deciding at what point the difficulties of setting up the machine will outweigh the economy realized by reducing the volume of the package.

Maximum Weight and Charges

This question of reducing the volume is worthy of the closest attention of American manufacturers as the freight from the United States to French ports is extremely high by the direct lines, while the extra duties charged upon goods arriving indirectly more than counterbalance any savings in transportation charges. The cost of transportation is, therefore, an important factor in the cost of a machine when delivered in France, and the economy realized by paying close attention to the volume of packages may form an appreciable portion of the profits.

The maximum weight of each package must also be carefully considered; freight charges, computed, as has already been shown according to weight or volume, as may be more profitable to the carriers, are increased very considerably when the weight of individual packages exceeds a certain limit. For instance, the rate for packages exceeding 4½ tons in weight is double that for packages weighing less than 2 tons. This increase varies according to the steamship line, but is imposed by all, and must therefore always be taken into account.

In addition to its effect on the actual freight charges, the total weight per package when exceeding a maximum of about 2 tons involves extra charges for loading and unloading. These charges vary according to the equipment of the ports of departure and arrival, and are often very considerable, as when it is necessary to move the vessel under a dock crane, when one is available, or to get up steam on a floating crane to handle the heavy weights.

To sum up, it will generally be advantageous to dismount a machine weighing over two tons in order to pack it in several packages each weighing less than this maximum. Care must be taken, however, that the total tonnage or volume of the several packages does not exceed that of a single case, and that the difficulties of assembling the machine at destination do not more than counterbalance the economy realized on transportation charges. It is also profitable to dismount a machine weighing either more or less than two tons, when this secures a considerable reduction in volume, and when, as is generally the case with machine tools, the volume exceeds the limit of 40 cubic feet per ton.

Dismounting Fragile Projections

It is generally necessary to dismount fragile projecting parts, even when this will have no influence on the volume or weight of the packages. While it is true that these parts will be properly protected by the packing case during transportation, still they run the risk of being bent or broken during the operations of unpacking and setting up the machine. It is therefore preferable to remove and pack them in one or more separate boxes secured in the principal case. All delicate or fragile parts which cannot be removed should be carefully protected against rough handling during unpacking. All screw threads should be carefully covered with wood or rags, all tapped holes, oil holes, and in general all openings through which dirt can reach the interior of the machine should be carefully closed with wooden plugs.

Manufacturers are especially urged to tag all pieces which may have been removed with labels fully explaining their position on the machine. This precaution may appear exaggerated and useless if it is considered that the machines will only be assembled by mechanics understanding their construction, but certain American machines are novelties to many factories, and besides, before arriving at the works of the purchaser, the machine has to pass through the custom-house, and sometimes has to be exhibited in a sales room. Under these conditions it is necessary that people unfamiliar with the type of machine should know exactly the position and function of each of the detached parts.

Protection of Finished Parts

When a machine tool has been properly dismounted and divided for packing the very important operations of protecting the finished parts against rust must be carried out. Lack of care and attention in this operation may have very serious consequences. It is not necessary to point out what serious effects rust may produce on the finished parts of a machine; it should be remembered that after having passed three or four weeks en route, often inadequately protected from the rain and always subjected to the effects of dampness, a machine may remain during long months in warehouses before being unpacked, and it is easily seen in what condition a machine may be found if the finished surfaces have not been protected against rust by a thoroughly efficient coating.

*Prepared by Paul Roux, a member of the American Chamber of Commerce of Paris, with a view to facilitate commercial transactions between the United States and France.

There are two things to be considered in this question of protection—the nature of the protective coating and the method of applying it. Without stating what the composition of the coating should be, it is urged that this should be sufficiently fluid at the time of application to permit it to reach all parts of the surfaces to be covered; that it should be entirely free from all trace of acid in order that it may not attack the metal. It should dry very rapidly, in order that no surface should be exposed accidentally through chafing en route or careless handling in the custom house. It should be readily dissolved with oil, petroleum, or turpentine when the machine is ready to be set up at its final destination.

Damage From Rust

The coating should, of course, be applied carefully to all polished surfaces which can be reached by the atmosphere, and care should be taken that the coating is intact after the machine has been packed—that is to say, when the packing case has been constructed around the machine. It very often happens that the packers carefully coat all polished parts of a machine, but that more or less of the coating is removed during the handling necessary for placing the machine in its packing case, or by contact with the interior braces. The effects of this negligence are generally very serious, because the parts thus exposed are promptly attacked by rust, and the machine cannot be put in perfect condition, even if this be possible, except by long and costly work.

Polished surfaces which are in contact with each other should not be coated; they will be sufficiently protected by the lubricating oil applied for running the machine. Likewise, oil holes should be free from the coating composition, as it is most difficult to completely remove it later on.

Finally, it is recommended that this coating be not applied to any finished parts, which, by their position in the machine, are completely protected from all exterior contact, and which are so situated that the removal of the protecting coat would be difficult. For these parts the employment of vaseline or solidified oil is suggested, as this can be readily removed, and even if not removed can not affect the working of the machine. The only precaution to be taken is that the vaseline and oil should be entirely free from acid. As an example, inclosed gearing, such as in the headstock of a lathe, can be protected in this manner against rust. Vaseline or solidified oil may also be employed for protecting such small detached pieces as may be inclosed in a separate box.

Construction of Cases

The packing case must fulfil two requirements—it must effectually protect the machine against all shocks and injury during transportation and must facilitate the handling of the machine; that is to say, the packing case is at the same time a covering and a vehicle.

In order to fulfil this double requirement the case should be specially constructed, and without fixing general rules, as the details of construction will vary considerably with the forms of different types of machines, the essential requirements will be given for packing cases containing a machine which is of a weight too great for moving by hand.

The bottom is the most important part of the case, considered as a vehicle. If this is well designed it will not only facilitate handling during transportation from the United States to France, and contribute greatly to removing risk of injury, but it is the only part of the case which can be utilized in France if, after remaining in show rooms, it is to be shipped by rail to its final destination. The bottom should therefore be sufficiently strong to carry the total weight of the machine without the assistance of any other part of the case when balanced on a roller. It should be constructed with two longitudinal battens in order that the case may be moved on rollers when cranes are not available, and these battens should be beveled at the ends to facilitate their employment. Transverse planking, spiked to the battens, forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts, in such manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends, and top of the case, which are designed simply for protecting the machine generally. In constructing the packing case the remarks already made regarding its volume must be borne in mind. This volume is computed from the over-all dimensions, as often a bolt-head or a batten badly placed will largely increase this.

Customs Examination

In designing the packing case it is very necessary to make provision for the examination of the machine in the custom house, and even for removing it completely. It is absolutely necessary in all events to arrange an opening in one of the sides or in the cover through which the nature of the machine may readily by seen. This opening should be large enough to permit the examination of all parts of the interior of the case and to permit the passage of a lantern if required. It should be closed by a cover secured with screws.

To allow for removing the machine completely from the packing case, in order to determine the net weight of the machine for the custom-house, it should be arranged so that the packing and the unpacking may be readily and rapidly accomplished without it being necessary to injure the panels. For this it is necessary that the top and one of the sides be secured with screws instead of nails, and that the position of the interior battens and braces be indicated externally in order that the screws and nails fixing them may be readily found.

It is especially recommended that the interior of packing cases be not lined with paper. Such a lining prevents the circulation of air, and if the machine be packed in a damp atmosphere the humidity, which under other circumstances would have evaporated, will attack the metallic parts, however slightly exposed. Special attention is called to this point, as practical experience has demonstrated that effects have resulted from lining cases quite unforeseen by the exporter.

Lists and Drawings

It is very necessary that the machine should be accompanied by a detailed list of the detached pieces contained in the packing case, which, on unpacking, will show whether any part has been lost during transportation or during the custom-house examination. It is most indispensable that this list should be accompanied by a drawing or cut showing clearly the machine when assembled and ready for work. The cut should also show all accessories which are indispensable to the machine—for example, countershafts, keys and wrenches, change gears, etc. This cut, in lieu of which a drawing should be supplied, will permit the custom-house inspectors to convince themselves that the detached pieces actually form part of the machine; otherwise these pieces may have to pay duties at a higher rate than the machine itself. If the machine has been taken apart and made up into several packages, a cut or drawing should be placed in each case, as in general all of the packages are opened in the custom-houses.

These papers, lists, cuts and drawings should be carefully enveloped in waterproof paper and tacked inside the case near the small opening already mentioned, in order that they may be readily accessible. When the dimensions are such that the papers can be attached to the cover of the opening this should be done.

Exterior Marks

The packing finished, it only remains to properly mark the cases for identification. All manufacturers know that a case should be marked legibly with identifying marks and numbers, the gross and net weight, the volume, and the name of the port of discharge, the latter in legible lettering at least 2 inches in hight. It is only necessary to call their attention to the necessity

of marking the absolutely exact net weight, as even a very small difference between the weight stated and the true weight may cause difficulties in the custom-house, and perhaps the imposition of fines. The volume is determined by taking the three dimensions over all. In addition to these marks, indispensable for the transportation of the package, and which should, when possible, be placed on the sides of the case, it is recommended that on each end of the package a short designation of the contents be added. These last-named inscriptions are absolutely necessary when the package is to be stored in a warehouse, as they permit of the immediate identification of a case containing a given machine. The inscriptions should not only indicate the type of the machine, but should also give its size or number.

Finally, exporters are urged to paint a black circle around the heads of all nails and screws which should be removed in order to unpack the machine with the least work and without injuring the panels and bracings.

If the bottom of the case has been given the special form herein indicated, there is little chance that it will be placed otherwise than upright; it is, however, better to add the usual indications, "top," "bottom," etc.

If the foregoing suggestions are carefully followed, manufacturers will greatly diminish the risk of injury or deterioration during transport, and will spare the consignee of the machine and the purchaser in France the trouble, delay and expense which the loss, damage or breakage of an essential part of the machine will cause him. The importance of properly bracing and securing a machine in its packing case has not been insisted upon, as the methods must vary greatly with each type of machine. The manufacturer should know how to arrange the bracing that the stresses to which the case may be subjected will be properly distributed and only brought to bear on such parts of the machine as may be capable of resisting them.

The probability that, as a result of the new South African customs arrangements, a number of manufacturing industries will be started with at least reasonable prospects of permanency opens up some interesting possibilities for makers and exporters of machinery. During the last five years South Africa has expended $50,000,000 on new machinery, and the total value of the machinery in the country at the present time is estimated at no less than $150,000,000.—*British and South African Export Gazette.*

The amendment to the so-called "free-alcohol" bill makes it possible for farmers and others to make denatured alcohol in a small way, overcoming the main defect of the original bill.

Books Suggested for Home Study

By H. L. Turner

At page 8, Vol. 28, Part 1, of the American Machinist, there is an article by Ernest McCullough outlining a home-study course. As I was and am still pursuing such a course, and as I know there are thousands of others doing the same thing, I expected and hoped to see something further on the subject.

But as no one else seems to have anything to say, and with a view to starting a profitable discussion I would like to make a few remarks about the course recommended by Mr. McCullough, and also to outline a part of the course I am following.

The first book recommended is "An Introduction to Machine Drawing and Design," by D. A. Low. For two reasons I do not believe this book is entirely suitable: First, it assumes a previous knowledge of practical and descriptive geometry; second, being an English work, all drawings are made in the first angle, which is liable to cause confusion to the American beginner.

The "Technic of Mechanical Drawing," by Rhienhart, I have found to be a very useful book.

He then recommends Castle's "Practical Mathematics." For the following reasons I do not like this book: It carries the subject of algebra only as far as simple simultaneous equations, saying nothing of quadratics or higher algebra. In the part on trigonometry it gives only the solution of right triangles, and though it gives a little of what might be called analytical geometry, it does not give enough to enable one to study the calculus. It almost entirely avoids the subject of geometry, thus depriving one of much valuable mental training, which I have found to be indispensable. "Higg's Algebra" is all right to study with some more extensive work.

Under mechanics he recommends "The Elements of Physics," by Henry Crew, but I do not think this one book contains enough physics for an engineer.

Before outlining the course I followed I wish to say that after a great deal of experience in my own case and in coaching others I have found that it does not pay to bother with any of the so-called "easy," "practical," or "short" works on mathematics, commonly turned out for home-study purposes.

The way I look at it is this: The ordinary school and college text-books on any subject are usually written by experienced teachers of that subject, men who know by experience the best way to present a subject so it can be easily understood.

Though school and college text-books are usually meant to be studied with the aid of a teacher, they are generally so complete and their explanations are so clear that any ordinary person should have no difficulty in understanding them without a teacher.

The objection to most books especially written for home study is that the author seems to think that his reader is a little brighter than ordinary persons, needs less explanation and fewer problems than would be given in an ordinary course. I believe, however, that a work written for home study should have more explanation and more problems for the student of this class of book has not the advantage of class-room work and a teacher's aid.

I will now give a list of some of the books I use, and the order in which they can be studied.

The first is "Wentworth's New School Algebra," and when it is completed as far as simple equations, Carhart & Chute's "High School Physics" and "Wentworth's Plane Geometry" can be taken up and completed with the algebra.

Next, Wells' College Algebra," "Wentworth's Solid Geometry" and "Wentworth's Plane Trigonometry" can be taken up.

The geometry and the plane trigonometry will be finished before the college algebra, and should be followed by "Wentworth's Spherical Trigonometry" and "Wentworth's Plane and Solid Analytical Geometry," which can be finished with the algebra.

Next "Nichols' Differential and Integral Calculus," "Hall's Descriptive Geometry," and "Anthony and Bracket's Physics," can be taken up and finished together.

If one is in a big hurry to study mechanical drawing he can take up "A Course in Mechanical Drawing," by John S. Ried, along with the "School Algebra," and follow it with "Machine Design," by the same author.

Among the books I have found useful for further study are: Goodeve's "Principles of Mechanics," Stahl & Wood's "Elementary Mechanism," Unwin's "Machine Design," "Things Usually Wrong," by J. A. Sweet (especially good), "Kent's Pocket Book," "Trautwine's Pocket Book," Thurston's "Manual of the Steam Engine" and Thurston's "Manual of the Steam Boiler."

I do not claim that any of the books in the above outlined course are the best; but each is a fair representative of a large number of books on the same subject, any one of which would probably be equally good.

It must be understood that I present the above with the object of stirring up someone who has a better knowledge of the subject than I, for as my own knowledge of colleges and such educational institutions has all been gained by a limited view of their grounds and buildings, I cannot claim to be an authority on education.

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Research Fellowships in Engineering at the University of Illinois

The University of Illinois has extended and strengthened the field of its graduate work in engineering by recently establishing ten research fellowships in the engineering experiment station. These fellowships have an annual value of $500, and are open to graduates of approved universities and technical schools, both American and foreign. They must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the master's degree will be granted. Preference will be given to men who have had some experience in practical engineering work outside of college.

The engineering experiment station is a department connected with the college of engineering. It was established in 1903 for the purpose of carrying on investigations along various lines of engineering, and for the study of problems of importance to professional engineers and to the manufacturing and industrial interests of the State. The work of the station and the college is closely related, the heads of the several departments of the College of Engineering constituting the station staff. The investigations are carried on by the members of the staff directly, sometimes by a fellow as graduate work, sometimes by a member of the instructional force of the college, and frequently by special investigators belonging to the station corps.

The various laboratories of the station and the college offer exceptional facilities for investigational work, being well-equipped with the most modern apparatus. During the past four years about $300,000 has been appropriated by the State legislature for the maintenance and extension of this equipment, and it is believed that the same liberal policy will be continued.

A circular giving full information will soon be issued, and can be obtained upon application to Prof. L. P. Breckenridge, director of the engineering experiment station, Urbana, Illinois.

Union Meeting of Machinery Associations

Recently a conference was held in Cincinnati, O., attended by representatives of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association, the American Supply and Machinery Manufacturers' Association, to consider preliminary arrangements for the annual meetings of these associations at the Hotel Sinton, Cincinnati, May 8, 9 and 10, 1907.

A conference committee, consisting of three members from each association, will be appointed by the respective presidents thereof, to which questions bearing upon work of the three associations will be referred; its purpose being to consider such matters and report their findings to their respective associations or to joint sessions as may be desired.

Separate executive sessions and a joint executive session of the three associations will be held, and at the latter, papers on cash discounts, re-sale prices, cost of doing business, and relation between manufacturer and dealer will be presented.

The novel and interesting feature is here presented of manufacturers and dealers frankly discussing business questions which until recently have been considered by many the confidential information of each separate class.

The Metric System Defeated in the British Parliament

We learn by a press despatch that the bill for the adoption of the metric system in the United Kingdom was rejected on its second reading before the House of Commons, March 22.

For years the Decimal Association has published statements showing the strength of the system among the members of Parliament. For at least two years it has figured out a clear majority for the measure and has only asked for a vote on the subject in order that the bill might be definitely passed. Immediately prior to the test it figured out a favorable vote of over 400 out of less than 700 total members, but the calculations seem to have been as wide of the mark as in some other conspicuous cases and the measure seems now to be definitely killed.

The metricites will, we suppose, continue to extract comfort from their touching belief that "it is bound to come," and that appears to be the only source of comfort that is left to them.

The New Swedish Tariff

The new tariff for Sweden contains the following provisions of interest to the trade:

Electrical machinery, including dynamos, electro-motors, and electric transformers, and spare parts thereof, 15 per cent. ad valorem.

Apparatus for lighthouses and parts thereof, 10 per cent. ad valorem.

Locomotives, 10 per centum ad valorem.

Other not elsewhere mentioned and parts of railroad material, 10 per cent.

Machines, apparatus, and tools therefor not specially mentioned, 10 per cent. ad valorem.

Bolts and nuts for railways, also other unenumerated bolts, with or without thread, $1.608 per 100 kilos.

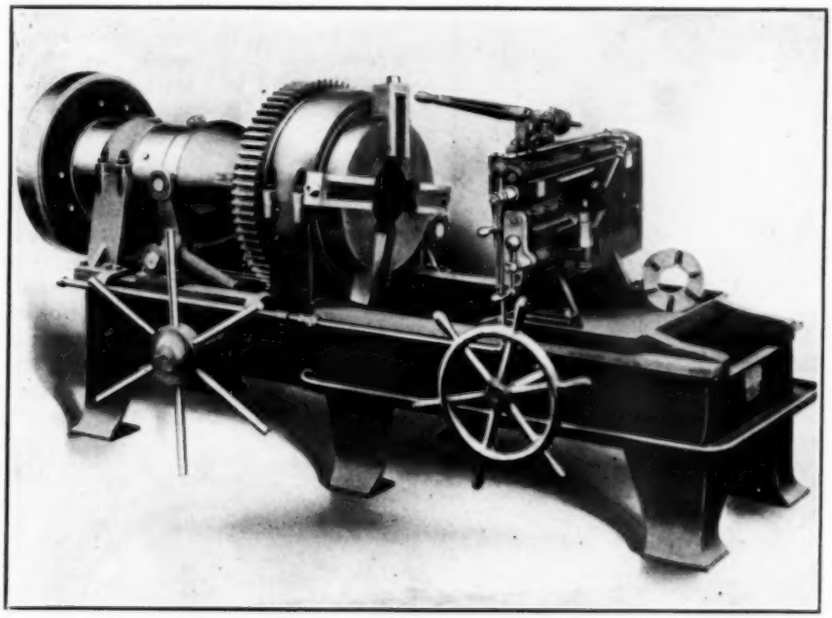
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

Pipe-Threading and Cutting Machine

The new size pipe-threading and cutting machine shown herewith has a quick-operating chuck, manipulated by means of a hand-wheel and pinion which engages in a rack on the end of the cone-shifting arm. The cone slides freely on the arbor, and as it is moved forward, the chuck arms, having rollers in the end, roll up on the large diameter of the cone, thereby tightening the jaws on the pipe. When the cone is moved back, springs draw the jaws away from the pipe. The steel jaws in the chuck are graduated, and when they are once set for a size of pipe, the entire lot can be threaded without stopping the machine. The rear chuck is provided with three independent jaws with which fittings can be made up, also with bushings for holding the pipe central, without gripping it. Eight changes of speed are obtained through a four-step cone pulley and shifting gears. The well known Peerless Die-Head is used, which is simple in all operations.

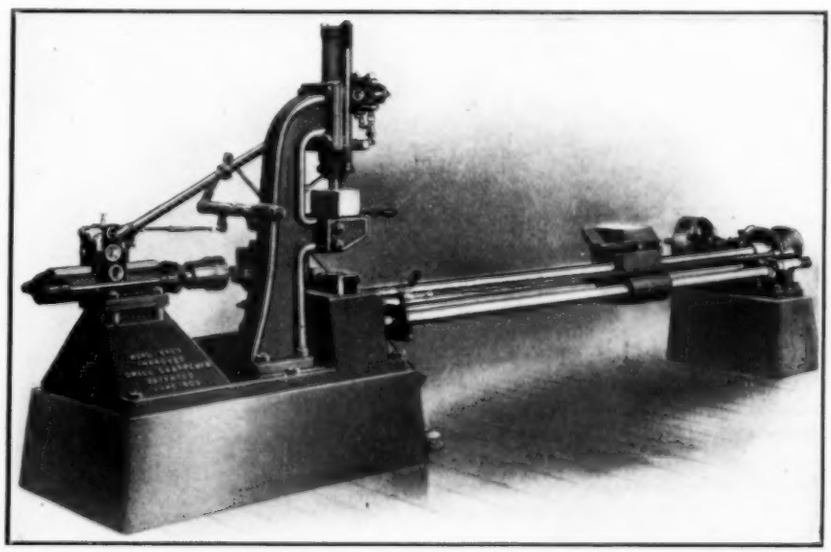


PIPE-THREADING AND CUTTING MACHINE

The machine is made in a range of ten sizes, 1¼ inches to 6 inches, inclusive, by the Bignall & Keeler Manufacturing Company, of Edwardsville, Ill., who designate it their P. D. Q. C. No. 6.

A Rock-drill Making and Sharpening Machine

The illustration shows a machine for making and sharpening drills used in stone. The machine consists of a cast-iron bed plate, with two power hammers, a vertical and horizontal, mounted thereon, and a dead block carried by guide rods which are attached to the bed plate.



A DRILL-MAKING AND SHARPENING MACHINE

The hammers are actuated by compressed air, and are equipped with automatic controlling valves which permit the operator to handle both hammers by a single foot treadle, which is pivoted under the hollow of his foot, enabling him to operate the machine without moving his foot from one place. By a pressure of the foot on the toe of the treadle, the horizontal hammer is brought into action, the intensity and speed of the blows are governed by the pressure of the foot on the treadle, by releasing the pressure of the foot on the toe of the treadle, the hammer is stopped by the controlling valve, which acts instantly, shutting off the supply of air to the hammer, bringing the piston to a retracted position and the foot treadle to a level, or central position. By a pressure of the foot on the heel of the treadle the vertical hammer is started and stopped in the same manner. The foot treadle is always brought to a central or neutral position by the controlling valves when the pressure of the operator's foot is removed or resting equally on each end of the treadle, and the pistons of the hammers, carrying the dies or hammer heads, are always brought to the upward or backward stroke and held there. These controlling valves also prevent one hammer from coming into action while the other hammer is in use. Their importance, in a machine of this kind, is illustrated by the fact that the time required by them to stop one hammer, hang it up safely, and start the other hammer under a full head of air is one-tenth of a second.

In line with, and moving to and from the horizontal hammer is the dead block, a casting faced with tool steel, which the drills or steels rest upon and which receives the impact of the horizontal hammer when it is in action. This dead block is supported by guide rods, bolted to the bed plate. It is moved by a screw, which in turn is driven by a friction gear running 600 r.p.m. The dead block is adjusted to the different lengths of drills, accurately and quickly, by a slight pressure on a lever, bringing it forward or backward as desired.

Between the horizontal hammer and the dead block are adjustable split dollies which work on the cutting edges of a drill, and which forge and sharpen all sized drills without any change. The horizontal hammer strikes these dollies rapidly, which are driven against the drill bit, and which rebound slightly at every blow. While they are thus being struck, they are opened and closed by a cam lever attached to the guides carrying them. This opening and closing of the dollies, while they are working on a drill or a blank piece of steel, prevents undue buckling or bending of the steel, as the dollies work only on two wings of a drill bit at a time, the other two wings of the bit bracing and supporting the wings thus being worked upon. This causes the metal in the wings of the drill to be equally distributed and hammered alike, so that the whole bit is a homogeneous mass of equal density and compactness, permitting the drill to take a high temper and stand up to hard work, without broken corners or battered edges.

The vertical hammer carries dies suitable for the work to be performed and, like the dollies, they do not have to be changed in handling the different-sized drills. The function of the horizontal hammer is to swage and gage the drill bits and to properly shape the wings of a new drill.

The weight of the machine is 4000 pounds. Its capacity is from 700 to 800 drills per day. The machines are manufactured by Word Brothers, 60 Castro street, San Francisco, Cal.

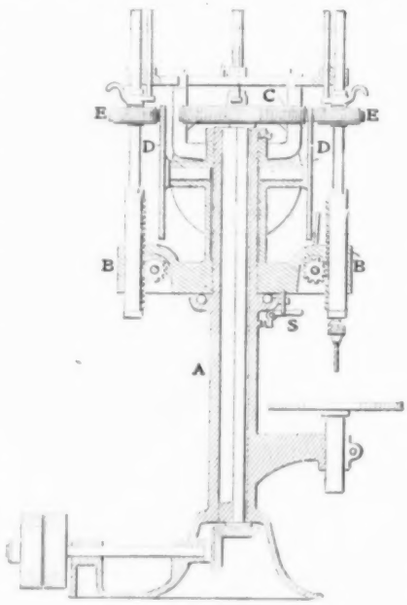
A New Sensitive Drill

This multiple-spindle drill press has several features that are novel and that should prove of value in actual shop work. The illustration is from a patent-office drawing and while not as satisfactory as might be desired, will show its new features.

The drilling head carries four spindles, each having its own friction wheel and driving disk *D*. This drilling head revolves around the column *A* on ball bearings, to bring any desired spindle over the table, the stop *S* locking it in place.

It will be noticed that the driving wheel *C* is not in the center of the column, and only drives the disk and drill spindle which is at work. This disk is supported on both sides, which is very desirable in such a drive.

As the drilling head is revolved, the one going off duty automatically stops



NEW SENSITIVE DRILL

when the disk leaves the driver *C*, and the approaching spindle takes up its motion on coming into contact with it.

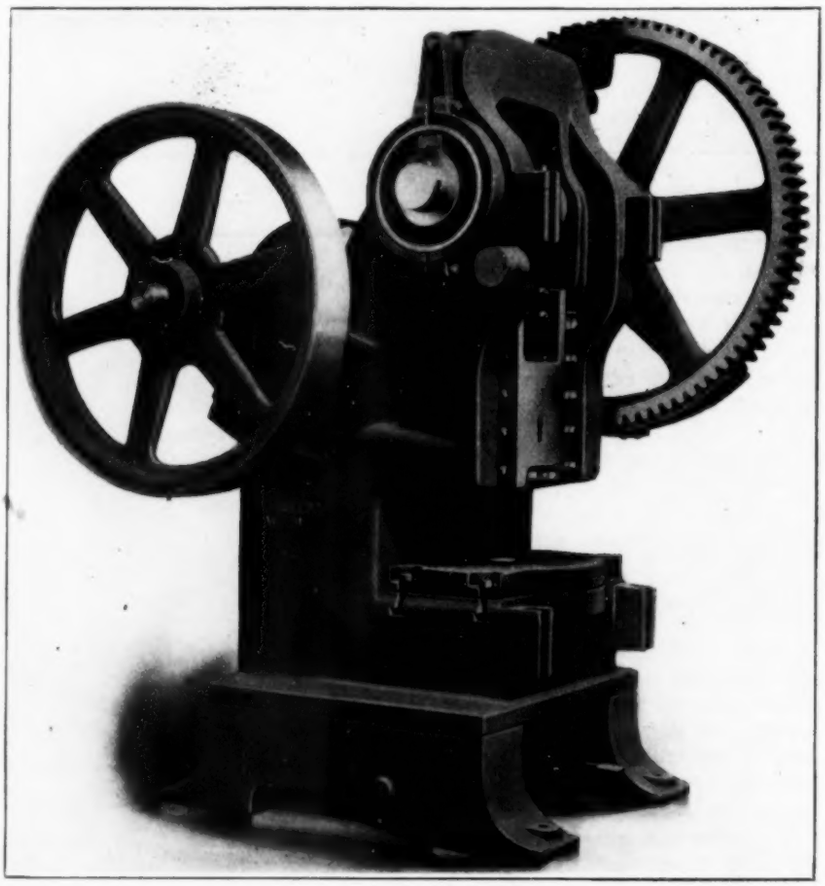
Another very desirable feature is that each spindle is independent of the other in speed as in everything else. This is obtained by varying the position of the spindle drivers *E E*, being adjusted separately to give just the desired speed to each.

It does away with all except the main belt, takes but little more room than the single-spindle drill and seems to have a number of advantages.

It has recently been patented by Corneil Ridderhof, Los Angeles, Cal., who has long been a contributor to these columns.

Large Blanking Press

The half-tone illustrates a new size of geared press with capacity for cutting large blanks of steel plate ⅜ inch thick, being suitable for making in quantities large disks, for which single rotary slitting shears with circling attachments were formerly used. In this machine the bed is 28 inches front to back and 36 inches from side to side; the back has an opening or space between housings of 24 inches, the gap being very convenient for the operator in feeding from right to left the heavy plates for the rapid production of the work. The distance from the bed to the slide is 13 inches, and the distance back from the center of the slide, 8½

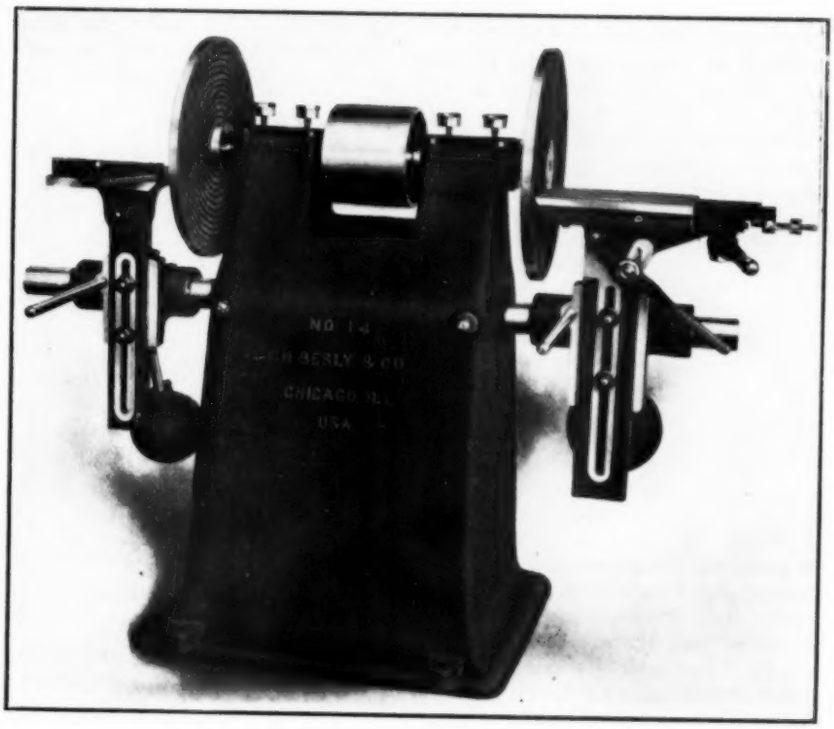


LARGE BLANKING PRESS

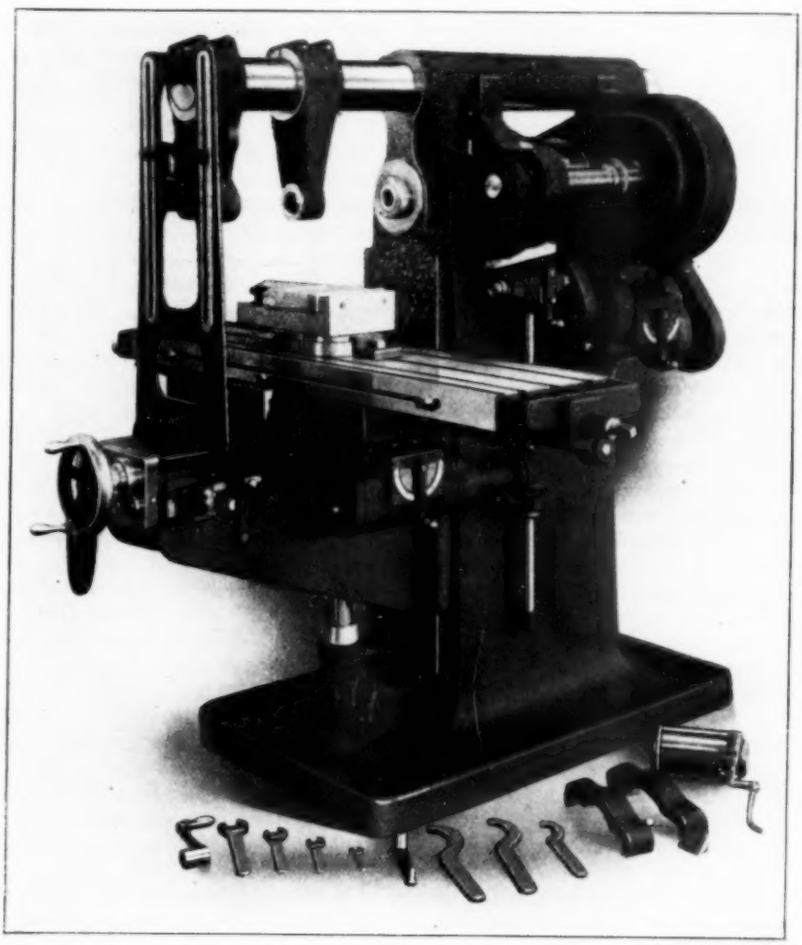
inches. The machine weighs about 18,500 pounds and has recently been placed upon the market by the Toledo Machine and Tool Company, of Toledo, Ohio.

Plain Milling Machines

The plain milling machine shown in the half-tone is a positive and automatic feed-geared machine, with 32 changes of the feed, which may be engaged or disengaged with the machine in motion without danger of injuring the working parts. The feed per revolution of spindle ranges from 0.003 inch to 0.300 inch. The maximum movements are 38x11x20¼ inches, and the table is 50x12½ inches. The machine is double back-geared, with 18 changes of speed, ratios 3:1 and 10:1. The floor space is 97 inches in line with spindle, and 104 inches wide to permit extreme table travel; the machine has a net weight of 4300 pounds and is the No. 3-B of the Owen Machine Tool Company, Springfield, Ohio, who make a smaller machine, No. 2-B, of similar design, the latter being, however, merely single back-geared with eight changes of speed, and with traverses of 28, 7½ and 19½ inches respectively.



SPIRAL DISK GRINDER



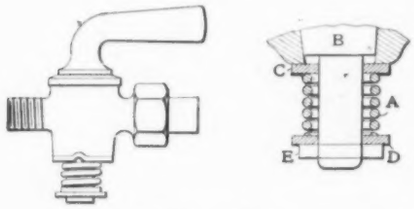
NO. 3-B PLAIN MILLING MACHINE

Spiral Disk Grinder

The disk grinder shown in the cut is a heavy, rigid machine, equipped with lever-feed table and powerful belt drive, for grinding work in manufacturing quantities, the construction being on a par with that of high-grade machine tools. The lever feed-table bed has T-slots and a key-way for attaching angle-plates or other work holders. The table is mounted on a gibbed dovetail slide and is moved to and from the disk wheel by a lever, pinion and rack, giving a leverage of 14 to 1. This is a desirable feature, as it enables the operator, without undue exertion, to turn out more work by getting the maximum efficiency of the abrading disk. The table is equipped with a micrometer stop screw, graduated to read in thousandths of an inch. The disk wheels are 20 inches diameter by about 13/16 inch thick, but the machine will swing 23-inch wheels. The end thrust of the spindle is taken on hardened and ground-steel collars of large area, between the cast-iron spindle pulley and the flanges of the bronze bearing bushings. The left-hand table carries the detachable bevel gage, graduated 45 degrees. Both tables may be tilted from their horizontal position, and have vertical adjustment and rocking motion, with adjustable counterweights. The machine with countershaft and floor press weighs about 3000 pounds and is made by Charles H. Besly & Co., of Chicago, and designated by them as their No. 14.

Spring-key Cock

The engraving represents an interesting example of ground-key work, the principal advantage in the construction shown being the self-adjustment of the key; for should the latter wear in the least, the spring will immediately take up the wear and a tight joint thus be maintained. The improvement is shown clear-

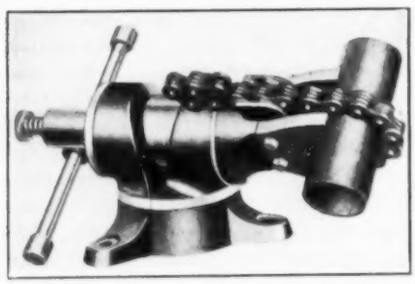


SPRING-KEY COCK

ly in the detailed view. The spring *A* is made of phosphor-bronze wire, and placed at the bottom of the key *B*. This spring rests between washers *C* and *D*, the whole being held in place by the cotter pin *E*. The tension of the spring is sufficient to hold the key firmly in place, but it does not prevent it from being easily turned. The maker is the Lunkenheimer Company, Cincinnati, Ohio.

A Double-swivel Pipe Vise

The vise shown in the half-tone illustration extends to work on pipes and fittings the same convenience and facility of adjustment afforded to the machinist in the double-swivel vise illustrated and described at page 357, Vol. 29, Part 2, viz., the work may be swung to any position in two independent circles with axes at right angles to one another; the vise may therefore not only be used as a pipe vise, but as a universal chuck for holding a pipe, nipple, or elbow, or other



DOUBLE-SWIVEL PIPE VISE

parts, when it is desired to work on them on the driller or other machine, the piece being held firmly at any desired angle. The vise has moreover a wide capacity, from ⅛ inch to 6 inches inclusive. After bringing the chain around the pipe and dropping the nearest link behind the lug on top, a turn of the handle grips the pipe and at the same time locks both swivels. The concealed end of the chain is attached to the inner portion of the screw. When the screw is tightened the pressure of the nut on the rear yoke or body section tilts the latter forward, so that the lower ends press outward against the circular base and lock the vise against rotation. Reference to the longitudinal section of a double-swivel vise in the article above referred to will make this quite clear. The base and the two yokes of the pipe vise are the same in design and size as those of the 3½-inch jaw double-swivel machinist's vise, so that the upper parts may be interchanged. In the pipe vise, as in the other, any desired friction can be had by adjusting two small screws in the friction plate, and by this means a stationary vise can be obtained when it is wanted. The maker is the Pittsburg Automatic Vise and Tool Company, Pittsburg, Penn.

Meetings of the Society of Automobile Engineers

At a meeting of the Society of Automobile Engineers, held at the Flatiron building, in New York City, Saturday evening, March 16, it was decided that there should be a summer meeting of the society held at Buffalo between July 20 and August 10. The meeting will occupy three days, of which one will be devoted to visiting the local automobile-manufacturing plants. A regular business meeting will be held early in May.

American Machinery Abroad

Although American makers do a good deal of the business with Cuba in supplying narrow-gage railroad cars for carrying sugar cane in bulk, weigh-bridges, alcohol engines, etc., yet they might very well add to their trade in that direction. There is plenty of opening there for cheap, serviceable, standard narrow-gage cars, and also for ox- or horse-cart weigh-bridges, which are used for the purpose of weighing the cane before delivery to the railroad companies. The demand continues brisk for steel rails, railroad wheels, axles, repairing tools for locomotives and cars, etc., while many inquiries are made for alcohol engines for driving repair machinery during the dead season in the sugar mills, when it is inconvenient to use the main boilers.

A Large Mexican Contract

The Mexican Government has contracted with a private firm (Messrs. Doheny, Canfield & Brigde) for the establishment in Mexico City of works for the manufacture of oil gas, and plant for its distribution to industrial establishments, etc. The firm in question undertakes to spend at least 500,000 pesos on the works and plant, tools, etc. All the machinery, tools, etc., needed for these works may be imported free of duty; also electric-lighting material, and fire-extinguishing apparatus. It is projected to establish similar undertakings in other parts of the republic. There should be chances of substantial business arising from these contracts.

Progress in Turkey

There is further indication of the opening up of the Ottoman Empire in the formation of an official commission to consider measures for the development of parts of the country. I have occasionally directed attention to this fact in these columns. With the opening up of the country to trade and the increase of cultivation, the demand for various mechanical appliances of every description is bound to increase largely. From the latest and best news received there is already a considerable demand for oil pumps at Basra and Bagdad. But it must be remembered that it is all very well to introduce machinery, but what if none of the purchasers are able to install it or manage it when installed? Apparently the only way out of the difficulty is for the engineering firms themselves to undertake the instruction of the purchasers. It is very clear that if any engineering firms wish to share in the profits that will certainly accrue to the engineering trade as a whole from the opening up of the country, they must set to work themselves to push their machinery and to instruct their clients how to make the most advantageous use of their purchases.

A Cheap Motive Power Wanted in Argentina

One of the great needs in the Argentine Republic is for a cheap and trustworthy form of motive power. The days of the bullock for this purpose have largely passed away. This is more particularly the case in the districts where no cattle food is obtainable. In some parts, too, it is impossible to obtain wood for burning; in other localities water is very scarce. Oil engines, it was thought, would solve the problem, and although they have given very good results, yet they have not surmounted some of the difficulties. For instance, the combustion chamber cannot generally be gotten at and cleaned frequently, or some parts are too delicate to withstand the rough treatment they receive at the hands of laborers. Of course, the combustion chamber of an oil or gas engine is a most important part of the machine, and should be easily accessible whenever necessary. The ordinary type of portable steam engine on the four-wheel base holds a premier position. Its fuel is straw or maize stalks and costs nothing, while it has the very great advantage of being generally understood. The principal drawback is its great weight and heavy cost. The latter consideration especially prevents their being sold to small farmers and others who could find

work all the year round for a light portable steam motor of six or eight horsepower. In Buenos Aires itself, for a 10-horse-power steam motor of pretty well any name, the price is $2000 or $2500, paper, which is a sum quite beyond the reach of nearly all the small agriculturists. What is really needed is a lighter, simpler engine, easily drawn by a pair of bullocks over an ordinary road, and costing about $800 or $1000. If such a thing could be put on this market it would undoubtedly command a very large sale. Six horse-power is also a very useful size.

Hydrocarbon Motors Can Be Sold in British Honduras

By the way, while dealing with small motors, I may say that makers of oil or gasolene engines should open up communication with importers of such goods in Belize. There is a large demand in British Honduras for engines of that class. A certain number are already purchased in the United States, while it has paid one Swiss firm to open an agency in Belize for motors of this type.

The Prospects in South Australia

Owing to the constitution in South Australia of a number of local public authorities, there will very likely be a demand there for fencing wire, pumps, irrigation machinery, sanitary appliances, etc. Hitherto the State Government has seen that orders were given to home manufacturers, irrespective of price and other considerations, but in the future, quality and cheapness will decide as to who is to supply public wants. The work of railroad and tramway extension is being resumed in the State and large additional quantities of rails, tools, etc., will be required. The expansion of the mining industry has led to an increased demand for mining machinery. I cannot say that American exporters of mining plants show up very well in this market. For instance, in 1905, the latest available data, the exports from Britain to South Australia were valued at £44,000; Germany, £10,000; United States, £16,000. The German machinery was largely of a scientific character, that from America included numerous labor-saving arrangements. The use of oil engines at the mines is becoming more general, and a ready market awaits those of the largest kind, especially in districts where the water supply is not over plentiful.

England. F. C. C.

New Publications

Annual Report of the Board of Regents of the Smithsonian Institution. 576 6x9-inch pages, with 98 illustrations. The Government Printing office, Washington.

This publication contains the usual reports regarding the expenditure of funds, and the report of the secretary on the various activities of the institution. A general appendix, which comprises by far the larger portion of the book, chronicles the most noteworthy recent advances in science.

Questions and Answers from the Gas Engine. 274 6x9-inch pages. The Gas Engine Publishing Company, Cincinnati, O. Price, $1.50.

The answers to inquiries column of the *Gas Engine* having resulted in the accumulation of sufficient material of permanent value, it has been collected together and the present volume made from it. The questions and their answers relate to pretty much every feature of the design, construction, operation and repair of gas and gasolene engines, and the answers are said to be by recognized authorities, whose names are, of course, not given.

The Steam Engine and Other Heat Motors. By W. H. P. Creighton. 499 6x9-inch pages, with 198 illustrations. John Wiley & Sons, New York; Chapman & Hall, London. Price, $5.

This is essentially a text-book, designed for the use of students in schools of engineering, and as such it mixes the practical with the theoretical—descriptions of engines and accessory machinery, and the use of the indicator appearing side by side with the essentials of thermodynamics. The combination of indicator cards from compound-engine cylinders is discussed more fully than is usual. Chapters on steam turbines, gas engines, gas producers, and refrigeration are included.

Concrete Factories. By Robert W. Lesley. 152 7x10-inch pages, with numerous illustrations. Bruce & Banning, New York. Price, $1.

No subject is attracting more attention at the present time among manufacturers and engineers than that of reinforced concrete, as applied to building construction, and the general interest in the subject is reflected by an unusual number of books upon it. The book under notice is essentially a compilation, and is far less technical than many others, although well stocked with information for the engineer as well as for the non-mathematical reader. Numerous illustrations of the various methods of erecting concrete buildings with various reinforcing systems are given, and a chapter is devoted to a translation of the French rules on reinforced concrete, which were recently issued by the French minister of public works. Considerable attention is also given to the surface finish of concrete in order to produce a pleasing architectural effect, and several very attractive illustrations of surface finishes are given.

Steam Turbines, Practice and Theory. By Lester G. French. 418 pages, 8¼x5¼ inches; illustrated. Hill Publishing Company, New York. Price, $3.

Commencing with a chapter on the principles of turbines, the author shows in such a way as to be easily understood, how the energy of a steam jet is transformed into rotary motion by the various types of turbines. Early types are given in order to show inventors what has already been done and prevent a repetition of errors along similar lines. The various types of turbines now in use are shown with necessary details, and this is followed by a section of 89 pages giving the results of various tests and the performance of turbines in comparison with reciprocating engines. Vacuum and superheating are also considered. Other chapters take up the flow of steam and show how it can be calculated, the design of vanes for turbines, which has been made as clear as possible; rotating bodies at high speed; balancing; commercial aspect of turbines; condensing apparatus and marine turbines. The chapter which will appeal to running engineers is the one on care and management of turbines, which gives the practical experience of men in charge of turbines, information which is not available in any other way. The author was editor-in-chief of *Machinery* for a number of years, which gave him an excellent opportunity to secure his facts, and he has presented them in a way that can be easily understood by the average reader.

Personal

C. D. Gibson, of the Pratt & Whitney Company, resigns his position on April 1 to assume position as superintendent of the B. F. Barnes Company, Rockford, Ill.

R. J. Sutton, after two and a half years' residence in Canada, where he has introduced the premium plan of paying for labor in several of the largest machine shops in the Dominion, has returned to this country and is now located at 73 Eppirt street, East Orange, N. J. He intends making the introduction of the premium plan a specialty.

Our contributor, R. H. Palmer, late foundry superintendent for R. Hoe & Co., of this city, has resigned his position and goes immediately to Elkhart, Ind., where he becomes superintendent of the Lake Shore & Michigan Southern Railway foundry. When leaving the Hoe foundry Mr. Palmer was presented with a handsome diamond ring by the molders, and with a Masonic locket by the helpers of that foundry.

Obituary

John Brislin, an inventor of modern rolling-mill machinery, of Pittsburg, Penn., died March 27, at the age of 70 years.

Thomas B. Brannon, for 37 years superintendent of the Lewistown Foundry

and Machine Company, Lewistown, Penn., died March 25.

Jacob Reese, of Sharon Hill, Penn., died March 25, aged 82 years. He held 300 letters patent on inventions connected with the manufacture of iron and steel, and was identified with the trade from early manhood. He built and operated works in Pittsburg, was interested in other ventures, and became very wealthy, but lost his fortune in a panic. He succeeded in partly retrieving himself in later investments.

Business Items

Nutter, Barnes & Company have issued a notice that on and after March 30, they will be located at their new factory, 326 A. street, Boston, where they will have increased floor space and a more complete equipment of modern tools.

Ralph Templeton, formerly of Whitman & Barnes Manufacturing Company, has been appointed the New York representative of the Pittsburgh Automatic Vise and Tool Company, of Pittsburg. Mr. Templeton's office is at 97 Warren street.

The Coes Wrench Company is to build large additions to its knife works, at Worcester, Mass., which will increase the manufacturing capacity of the plant 150 per cent. Not only will the knife works be enlarged, but departments in the new buildings will do work for the wrench works, which will increase the product of that department. There will be three buildings, all of which will be designed by Frank L. Coes, president and treasurer. The demand for Coes products has increased tremendously of late. Last year the growth in the wrench department was close to 25 per cent., reaching a total of 720,000 wrenches, not including what is known as the key model wrench.

Manufacturers

The Ford Motor Company, Detroit, Mich., is building a new factory.

The Carr-Lowery Glass Company, will erect additions to its plant at Westport, Ind.

The Link Belt Company, Chicago, Ill., will build a new factory at a cost of $18,000.

The Columbian Rope Company, Auburn, N. Y., will build an addition to its plant.

The Standard Coupler Company, Bridgeport, Conn., will erect a two-story addition.

The Carter Motor Car Corporation, Washington, D. C., is selecting a site for its new plant.

The Cambria Forge Company, Johnstown, Penn., is figuring on some extensive improvements.

The Weber Foundry Company, Cincinnati, Ohio, will build an addition expending about $25,000.

The C. P. Lesh Paper Company, Indianapolis, Ind., will put up a new plant to cost $54,000.

Chandler & Taylor, Indianapolis, Ind., engine and boiler builders, will erect a $5500 addition.

The Grays Harbor Light and Power Company, Aberdeen, Wash., will erect a new power plant.

The Pennsylvania Telephone Company will install a new plant in Reading, Penn., costing $100,000.

The Union Drop Forge Company, Chicago, Ill., contemplates the erection of a new manufacturing plant.

The Tolhurst Machine Works, Troy, N. Y., has awarded contract for a new four-story factory building.

The Avoca Wheel Company, Bath, N. Y., whose plant was burned some time ago, is preparing to rebuild.

The Buckeye Foundry Company, Cincinnati, Ohio, will erect a machine shop addition to cost $15,000.

The Industrial Works Company, Bay City, Mich., will erect a new steel foundry plant, also an erecting shop.

Extensive additions are being built to the cutlery plant of the International Silver Company at Norwich, Conn.

The McGregor-Banwell Fence Company, Detroit, Mich., will rebuild its plant which was recently destroyed by fire.

The National Acme Manufacturing Company, machine builders, Cleveland, Ohio, is erecting a new factory building.

The J. P. Devine Company, Buffalo, N. Y., will erect a new plant for the manufacture of its vacuum drying apparatus.

Reeves Bros., Columbus, Ohio, have incorporated as the Reeves Gas Engine Company, and will build a new plant.

Charles Mundt & Son, 441 Pearl street, New York, manufacturers of perforated metals, will erect a factory in Jersey City.

The United States Rubber Company, of New York, will erect a new building at its plant in Bristol, R. I., for the manufacture of insulated wire.

The Worcester Salt Company, Silver Springs, N. Y., is planning to install in the boiler room, an overhead coal bunker and coal handling machinery.

The H. B. Smith Foundry Company, Westfield, Mass., manufacturing radiators, boilers, etc., will build an addition and employ about 100 more men, it is said.

The Rapid Motor Works, Pontiac, Mich., will erect three new buildings, one to be a woodworking department, one a testing house, and one a dry kiln.

Mayer & England, of Philadelphia, and elsewhere, manufacturers of electrical devices, are having plans prepared for a group of buildings in Ambler, Pa.

The Westinghouse Electric and Manufacturing Company, E. Pittsburg, Penn., has broken ground for the erection of an additional $500,000 factory building.

The General Electric Company, of Schenectady, N. Y., has purchased seven hundred acres at Erie, Penn., and will build a plant at that place. About 4000 will be employed.

The Erricsson & Moon Manufacturing Company, Detroit, Mich., manufacturers of dies, tools, metal specialties and gasolene engines, will erect a modern factory building.

The Keystone Steel Castings Company has been organized at Chester, Pa., with a capital of $100,000. A plant will be erected for the manufacture of crucible steel. A. G. Lorenz, president.

Walter H. Judson, Portland, Ore., formerly of the Pullman Car Company, is at the head of the movement to organize a company to manufacture cars. $500,000 has already been subscribed.

The Union Manufacturing Company, New Britain, Conn., manufacturers of lathes and drill chucks, has awarded contract for the construction of two new foundry buildings at its plant.

Burd P. Evans & Co., Philadelphia, Penn., have plans posted for the plant to be erected at Bristol, Penn., for the Standard Cast Iron Pipe and Foundry Company. This plant will cost about $300,000.

The Alton Manufacturing Company, 451 Greenwich street, New York, making gas fixtures, etc., desires catalogs of brass working and tool room machinery. These should be addressed to H. J. Bachmann.

The plant of Dodd & Struthers, Milwaukee, Wis., manufacturers of lightning rod and electrical apparatus was practically destroyed by fire, causing a loss of about $95,000. It will be rebuilt at once.

Plans have been completed by Admiral Mason, chief of the Naval Bureau of Ordnance for the construction of a torpedo factory at the Newport (R. I.) Naval Station. About 200 men will be employed.

The Buffalo (N. Y.) Copper Rolling Company is being organized with a capital of $500,000. A plant will be built at Black Rock. Robert L. Fryer, Franklin D. Locke and others, of Buffalo, are interested.

The American & British Manufacturing Company, Providence, R. I., will erect a new machine shop, which is to comprise a new main building and three smaller ones. A one-story testing shop will also be erected.

The Gilbert Hunt Company, Walla Walla, Wash., intends erecting a large new plant in which to conduct its foundry business and the manufacture of agricultural implements. This, with equipment, will cost cost nearly $100,000.

The Kemper & Buck Manufacturing Company has been formed at Newark, N. Y., and will erect two buildings with a floor space of 15,000 square feet for the purpose of manufacturing wood products, doors, sashes, blinds, etc.

The Third Hand Manufacturing Company is being incorporated at Denver, Colo., with a capital of $50,000, to manufacture a sewing machine attachment and other mechanical novelties. James M. Butcher, of Denver, the inventor of the sewing machine attachment is one of the directors.

Trade Catalogs

Scully Steel and Iron Company, Chicago, Ill. March and April stock list.

Standard Connecting Rod Company, Beaver Falls, Penn. Booklet illustrating finished crank shafts. 3½x6 inches.

The Pittsburgh Automatic Vise and Tool Company, Pittsburgh, Penn. Series of blotters with illustrations of vises.

D. Saunders' Sons, Yonkers, N. Y. 1907 catalog of pipe-threading machinery. Illustrated, 131 pages, 6½x10 inches, paper.

The Electric Controller and Supply Company, Cleveland, O. Bulletin No. 107, illustrating and describing Type G controllers

Word Brothers, 90 Castro street, San Francisco, Cal. Catalog describing drill-maker and sharpener. Illustrated, 4½x7 inches, paper.

Niles-Bement-Pond Company, 111 Broadway, New York. List No. 13. Second-hand metal-working machinery. 51 pages, 4½x7 inches.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only

bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 75 Broad St., New York.

Caliper catalog free. E. G. Smith Co., Columbia, Pa.

Universal Test Indicator circulars free. H. A. Lowe, Lock Box 146, Cleveland, O.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Tools, dies and machinery built to order. Northwestern Machine Co., Detroit, Mich.

Expert machinist will consult and give advice. A. Frisk, 2240 Van Buren St., Chicago.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery to order, carbon and other molds specialty. O. Anderson, 30 Lawrence St., Newark, N. J.

Wanted—Tapping chuck, 0" to ⅝"; also horizontal broach, in good order; state make price. Box 3512, Philadelphia, Pa.

Special machinery accurately built. Screw machine and turret-lathe work solicited, and price. Box 3512, Philadelphia, Pa.

Special machinery to order. Catalog of small engines and boilers and engine castings 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

Wanted—Manufacturer to build in quantities, a new type of standard machine (compressor) in steady demand. Address R. C. Co., Box 821, Pittsburg, Pa.

Small automatic machinery for special work, models, jigs, etc., built to order. Satisfaction guaranteed. Novelty Engineering Association, Fitchburg, Mass.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Large floors for rent, 60x210 ft. in thriving country town near Boston and Providence; steam and electric power, light and heat; railroad switch. Apply to Box 773, AMERICAN MACHINIST.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

To correspond with men capable of filling positions as instructors in college machine, pattern, and forge shops; location, middle West; state age, full experience and education. Communications treated confidentially. Box 794, AMERICAN MACHINIST.

Wanted—To buy patent, or manufacture under royalty, any specialty where high-grade grey iron castings constitute 60 per cent. or more of total cost; would also consider New England or Eastern rights to established article. "Founder," Care AMER. MACHINIST.

Draftsman, engineers learn automobile drafting and designing including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

The shops of the Motor Car Specialty Company, at Trenton, N. J., in addition to building speed meters and other high-class speed recording instruments, are open for the manufacture of light high-grade machinery, on contract or royalty basis, either in large or small quantities.

An experienced designer desires to negotiate with responsible concern desiring to manufacture gasolene commercial vehicles to design for them a commercial truck or delivery wagon, which will be a practical success without experimenting. Address Box 808, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

Successful draftsmen drawing $125 to $200 monthly require thorough drafting room knowledge. As chief draftsman of engineering firm I know exactly the quality and quantity of experience and practical training you must have, and prepare you by mail, home instructions for above paying positions, which I furnish free anywhere. Complete highest grade drawing outfit, with German silver set of tools, value $13.85, free. Address Chief Draftsman, Div. 4, Eng's Equip't Co., (Inc.), Chicago.

Manufacturing Special—A mechanical engineer of experience has obtained U. S. patents for the manufacture of high-speed steel tools and has in operation a factory which has reached a point where it is paying expenses. He, however, needs further capital and would like to find a man with $25,000 or $30,000 to join him in exploiting the enterprise. There is not a more promising one today available. Fullest investigation desired, and best references given and required. Box 814, AMERICAN MACHINIST.

Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 10 o'clock a.m., April 9, 1907, and publicly opened immediately thereafter, to furnish at the navy yard, New York, N. Y., a quantity of naval supplies, as follows: Sch. 533; Hoisting engines. Sch. 535; Valve reseating machines, punch and shear, pneumatic countersinker, water tool grinder. Applications for proposals should designate the schedules desired by number. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y., or to the Bureau. E. B. Rogers, Paymaster-General U. S. N.
3-15-07

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Foreman pattern maker of large experience desires position; gasolene engine or automobile work preferred; Eastern States; exceptional references. Box 819, AMER. MACH.

Superintendent wishes to make a change, accustomed to fine and medium heavy interchangeable work; a designer of modern tools, jigs, and special machinery for rapid production. Box 784, AMERICAN MACHINIST.

ILLINOIS

Draftsman—Engineer in charge of large drafting room in the West wants work in the East. Box 776, AMERICAN MACHINIST.

MASSACHUSETTS

Blacksmith foreman desires change. Box 800, AMERICAN MACHINIST.

Superintendent or general foreman by man 45; has at present over 100 men; with present firm 10 years; thoroughly up-to-date on modern shop methods and high-speed production; best of references. Address Box 820 AMERICAN MACHINIST.

NEW JERSEY

Superintendent's assistant; practical man; 29; can estimate, do drafting and lay out work; wants position outside; will travel. Address Box 821, AMERICAN MACHINIST.

NEW YORK

Draftsman (graduate mechanical engineer), age 25, with shop and drafting room experience, now employed, wishes to change position. State full particulars. Box 806, AM. M.

Mechanical draftsman graduate; 3 years' experience, desires position. Box 804, AM. M.

College graduate; 4 years' shop and drafting experience, wishes to change position. Box 807, AMERICAN MACHINIST.

Position of capacity by oil engine man for designing, rate fixing, shop organizing, production, engineering. Box 799, AM. MACH.

Draftsman; experienced designer on special automatic machinery, having executive ability; wishes to change. Box 818, AM. MACH.

Mechanical engineer and draftsman; graduate German; age 25; 4 years' experience; desires change; New York or New Jersey preferred. Box 822, AMERICAN MACHINIST

Superintendent or master mechanic desires change; can control large volume economically, reduce operations and maintain interchangeability. Box 792, AMER. MACH.

Superintendent; age 37; wide experience on interchangeable work, special machinery and metal specialties; executive ability and excellent manager of men. Address Box 802, AMERICAN MACHINIST.

Mechanical draftsman, experienced in detail and construction work on automatic machinery; 4 years' experience and 2 years' shop work, wishes position in vicinity of New York City. Box 817, AMERICAN MACHINIST.

Position as foreman or assistant, by practical mechanic and toolmaker, thoroughly familiar with all kinds of automatic screw machines, having had charge of same for number of years. Box 796, AMERICAN MACHINIST.

Mechanical superintendent, employed, desires to make a change; expert toolmaker, machinist, designer and manufacturing economist; strong executive; salary secondary consideration. Box 795, AMERICAN MACHINIST.

Technical man, 35, good executive and mechanical ability, wants position, assistant engineer, superintendent or charge of construction; has held similar positions; best references. Address Box 797, AMER. MACHINIST.

Mechanical draftsman and designer (28); technical graduate with 8 years' practical experience on tools, fixtures and automatic machinery, good knowledge of manufacturing interchangeable parts, wants to change; position as assistant to master mechanic preferred. Box 825, AMERICAN MACHINIST.

OHIO

Mechanical draftsman; 20 years' experience; practical, on gas engines, special machinery, jigs and special tools; position desired in Ohio or Pennsylvania. J. H. Pilings, Xenia, Ohio.

PENNSYLVANIA

Superintendent or foreman; expert in manufacturing methods, several years' experience as executive, hustler and cost reducer; furnish best references from present employer. Box 816, AMERICAN MACHINIST.

WISCONSIN

Mechanical engineer; ten years' experience; manufacturing or shop engineering department. Box 798, AMERICAN MACHINIST.

FOREIGN

Automobile engineer, also experienced in steam engineering, machine tools, etc., wishes to represent and travel midlands for high-class firm; commission basis. E. L. Soper Nicholes, 35, Holly Lane, Smethwick, Eng.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Draftsman Wanted—Experienced in designing automatic machinery; give full particulars regarding experience, etc. The Bullard Machine Tool Co., Bridgeport, Conn.

ILLINOIS

Wanted—Patternmaker boss for pattern shop of steam engine manufacturer; pattern shop works about six men. Box 774, AM. M.

Wanted—Young man, who is a thorough shop man, to travel for a machine tool concern in the East; good opening for man not over 35, who is not afraid of hard work; not necessary to have had any experience as salesman, although such an experience would help. Address Box 815, AMER. MACHINIST.

Wanted—Foreman in the jobbing and special order department of large sheet metal works; department embraces light and heavy sheet metal of all description; applicant must have large experience and executive ability; German preferred; salary $1500. Address Box 803, AMERICAN MACHINIST.

MARYLAND

Wanted—By established automobile manufacturer, an experienced engineer and designer competent to design a four-cylinder gasolene touring car both with respect to desirability and economical production; good position with excellent opportunities for right man; give experience in reply. Address "Engineer," AMERICAN MACHINIST.

MASSACHUSETTS

Two or three first-class toolmakers. Box 793, AMERICAN MACHINIST.

Wanted—Tool and die makers accustomed to accurate, complicated work; steady work to thoroughly competent men; wages 40c. per hour subject to a liberal increase after showing the necessary ability; give references. Address The D. F. Briggs Co., Manufacturing Jewelers, Attleboro, Mass.

Experienced mechanical draftsman wanted by manufacturing concern near Boston, Mass., for designing of jigs, fixtures and special machinery; permanent position for the right man; draftsman with practical machine shop experience preferred. Address with full particulars regarding age, education, experience and initial salary expected to Box 766, AMERICAN MACHINIST.

MICHIGAN

Machinists Wanted—First-class machine hands and floor hands on heavy work; steady employment assured. Northern Engineering Works, Detroit, Mich.

MISSOURI

Wanted—First-class adjusters accustomed to adding machine and typewriter work. Universal Adding Machine Co., St. Louis.

Wanted—An experienced man to act as foreman in the assembling department of an automobile factory in the West. Box 812, AMERICAN MACHINIST.

Draftsman Wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 743, AMERICAN MACHINIST.

NEW JERSEY

Gas engine man wanted at once for installation and repair work. Steady employment. Apply, The Standard Motor Construction Co., 172 Whiton St., Jersey City, N. J.

Wanted—Tool, die and instrument makers accustomed to accurate, complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted—Foreman for foundry; open shop employing about fifteen molders, making machinery castings up to two tons; permanent position to reliable and capable man; state references, age and salary wanted. Address Box 811, AMERICAN MACHINIST.

Wanted—An experienced foreman of toolmaking department in a factory producing fine small mechanical work, on the interchangeable plan; the work done demands the highest skill and accuracy in fine tool work. An intimate knowledge of fine die and subpress work and modern up-to-date methods in all departments of fine tool making; it is absolutely essential that the applicant should have held a similar position elsewhere, and be possessed of good executive ability; the department employs from 30 to 40 men; references required. Box 789, AMER. MACH.

NEW YORK

Wanted—Experienced draftsman, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—Draftsmen; first-class on jig and fixture work; only those well up in this line wanted; good pay for right parties. 20-42 Ryerson St., Brooklyn, N. Y.

Wanted—Several first-class all-around machinists; in answering state where you have worked, how long and on what class of work. Box 823, AMERICAN MACHINIST.

An established, successful, dividend paying manufactory, wants executive for active, salaried position. Must invest $10,000 to $25,000; full investigation allowed. Address Box 810, AMERICAN MACHINIST.

Foundry foreman; western New York; general line; one pound to five tons, new modern foundry; melting 20 tons, wants up-to-date man who can show he has produced results; state in full name, age, experiences, references and salary wanted to start. Address "Foundry," AMERICAN MACHINIST.

Competent factory executive wanted; Western New York Manufacturing Company, manufacturing large line from medium interchangeable parts by automatic and semi-automatic machinery to large special units; capable man of high character, tact and experience in manufacturing lines with ability and business sense, who can show that he has produced results, and has capacity to rapidly advance to an executive position; state in full, name, age, past experiences, length of time different positions, responsibilities, references, etc. Address "Capable," AMERICAN MACHINIST.

OHIO

Wanted—First-class structural engineer capable of designing steel buildings, bridges, etc.; state age, qualifications, initial salary expected, etc. Address Box 567, AM. MACH.

Wanted—Technical graduate experienced on gas engines, to take charge of gas engine testing department of large works. Address, giving full particulars. Box 157, Salem, O.

Wanted—In Cleveland, Ohio, assistant working foreman, capable taking charge of eight punch and die makers for sheet metal stampings; state where formerly employed; class of work, and salary expected. Box 824, AMERICAN MACHINIST.

Tool Room Foreman Wanted—By an up-to-date manufacturing concern located in Ohio; must be able to design and supervise the making of small tools for both brass and iron work; write, stating fully, previous experience, references, age and approximate salary required. Box 790, AMER. MACHINIST.

Wanted—Mechanical drawing checker; an experienced practical and reliable man, age 30 or more, wanted by a large automobile manufacturer; must be experienced and have good mechanical ability to check drawings, see that parts will assemble without interference, and make estimates of material required in construction; permanent position and good salary for right man; references. Address Box 801, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First-class draftsman on mill construction and equipment, technical man preferred. Box 775, AMERICAN MACHINIST.

Wanted—Capable diemakers to work on heavy drop-forge dies; steady work for the proper applicants. Apply, giving references, as well as wages expected. Box 705, AM. M.

RHODE ISLAND

We are continually adding to our force, experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery. Good wages and steady employment. Apply to Taft-Peirce Mfg. Co., Woonsocket, R. I.

VERMONT

Wanted—A draftsman, one with experience on textile machinery preferred. Box 770, AMERICAN MACHINIST.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

Wanted—A good superintendent capable of handling pattern shop, foundry and machine shop departments in a general jobbing, repairing and manufacturing shop located in a rapidly growing city of two hundred thousand inhabitants, center of a big lumbering country in the West; one who could invest about $10,000 preferred. An excellent opening for the right man. Full investigation demanded and given. Address Box 692, AMER. MACH.

FOREIGN

Wanted—Gentleman (English or foreign), for technical correspondence and other office work; must be good linguist; state age, salary expected, and full particulars in own handwriting. Z. F. 699, Messrs. Deacons, Leadenhall street, London, England.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Planer, 24 in. by 6 ft., heavy Pease; good condition; running; $300. Bowers, 412 N. Darien Street, Philadelphia.

For Sale—Jobbing iron and brass foundry, located in western Pennsylvania; price $6000. Address Box 813, AMERICAN MACHINIST.

For Sale—Cyclopedia of modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

A well equipped machine and pattern shop for sale in New York City; manufacturing and jobbing trade; own power, whole building; reasonable rent; retiring from business. Box 805, AMERICAN MACHINIST.

For Sale or for rent; small foundry and machine shop doing good business; excellent opportunity for combined business and foundryman; located in manufacturing district eastern New York. Box 809, AMER. MACH.

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Hill, Clarke & Co., Inc., Boston, Mass.
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Prentiss Tool & Supply Co., New York.
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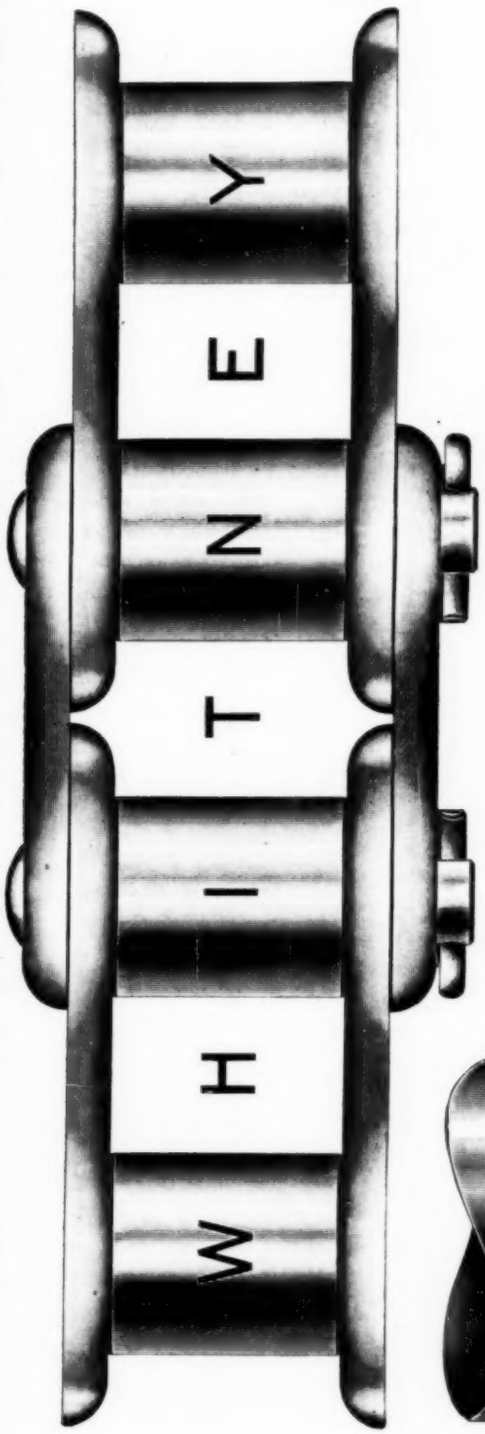

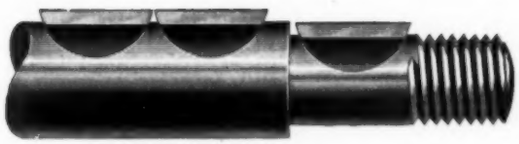

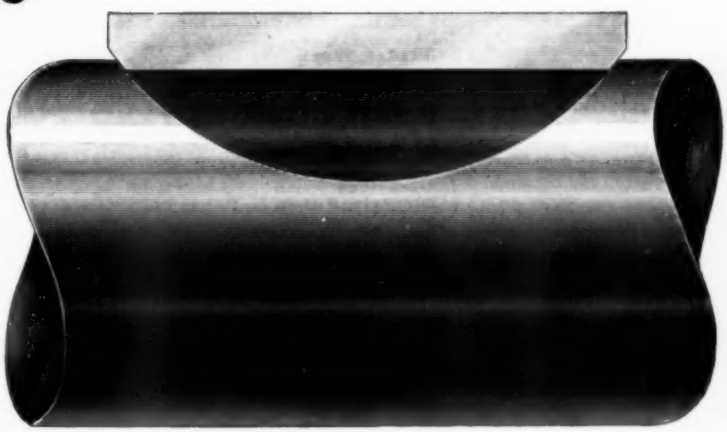

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Yost Mfg. Co., G. M., Mechanicsburg, Pa.

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Hoggson & Pettis Mfg. Co., New Haven, Conn.
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Niles-Bement-Pond Co., New York.
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Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
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Niles-Bement-Pond Co., New York.
Oneida Natl. Chuck Co., Oneida, N. Y.
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Skinner Chuck Co., New Britain, Conn.
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Sprague Electric Co., New York.

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Evans Friction Cone Co., Newton Centre, Mass.

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Standard Connecting Rod Co., Beaver Falls, Pa.
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Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
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Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

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Corundum
See Grinding Wheels

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Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

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Countershafts, Speed Changing
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Evans Friction Cone Co., Newton Centre, Mass.
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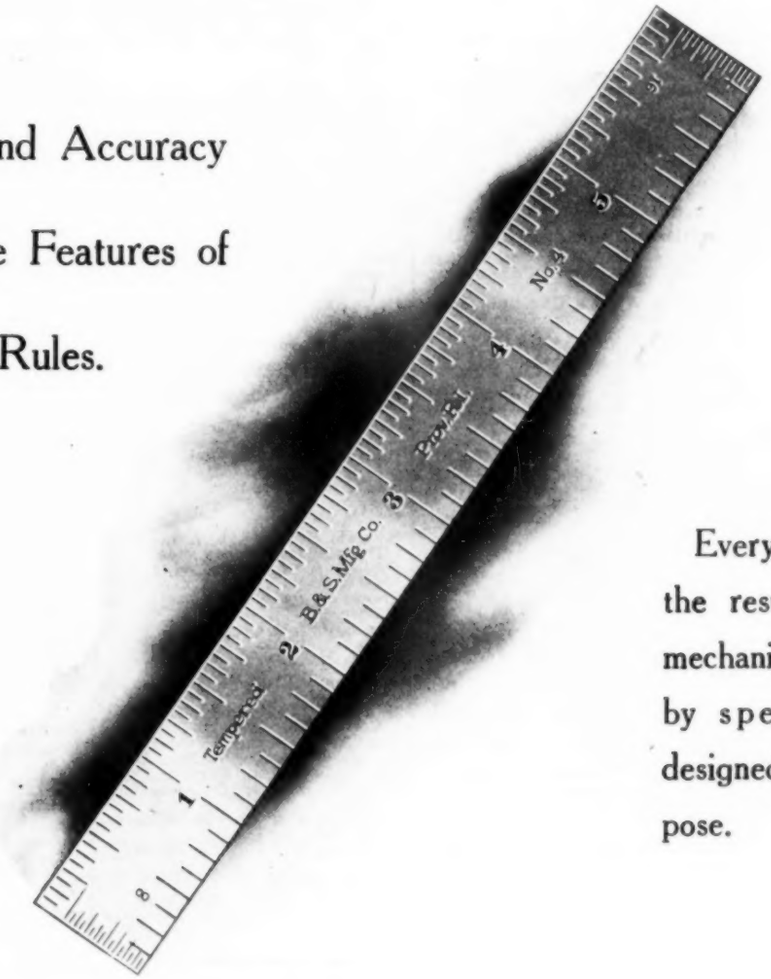

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The Haight Fly-wheel Joint Indorsed

Striking Examples of the Weakness of Fly-wheel Joints and Suggestions for Making the Joints of Belt Wheels as Strong as the Rims

BY C. H. BENJAMIN AND W. H. BOEHM

The article on "A High-efficiency Fly-wheel Joint," at page 267, shows a good example of applying a little common sense to the solution of a perplexing problem. Formerly the joint in a wheel rim was weak because of the deficiency of metal at the joint, as compared with that at other points in the rim.

Some tried to remedy this by putting more metal at the joint and often with a result the reverse of that intended. For example, increasing the weight and depth of flange in an ordinary flanged joint between the arms is usually increasing the centrifugal force faster than the strength of the joint. The correct principle, as first shown by Mr. Fritz, and then by Mr. Haight, is to reduce the metal in the rest of the rim, either by making it hollow as did Mr. Fritz, or by channeling as has Mr. Haight, and then bringing the joint over the arm where the excess of metal will not have the effect of bending and opening the joint.

This is somewhat analogous to the common practice of reducing the metal in the body of a screwed stud or stay, so that the threaded portion may have the same strength as the rest of the piece.

Perhaps the most important point of all is the location of the link or tie as near as possible at the neutral axis of the cross-section. The ordinary internal flange, with its bolts located perhaps several inches inside of the rim, was about as absurd an arrangement as could have been made.

An Object Lesson in Joints

Fig. 1 shows more plainly than words could do the weakness of such a joint under a bending action. This represents the flanged joint of a two-foot fly-wheel, as shown by a photograph taken after it had been broken at a speed of about 1800 revolutions per minute. Notice the way in which the joint was pried open by the push of the centrifugal force, the edge of the flange acting as a fulcrum, and the bolts being bent as the joint was opened. The bursting speed of a cast-iron wheel of this size with a solid rim is about 4000 revolutions per minute. Taking the squares of the respective speeds, we have the ratio of the strengths as 1 : 6.3.

When Links Are Used

At the same time some wheels having link joints similar to those commonly used in the fly-wheels of blowing engines and rolling-mill engines, were tested in the same way.

Fig. 2 shows one of these wheels after bursting at a speed of about 3000 revolutions per minute. Comparing this speed with that of a whole rim, we have a strength ratio of 1 : 1 7/9. All such wheels broke through the cast iron at the point of least cross-section, the links in all cases being stronger than the cast iron.

The wheels designed by Mr. Fritz and Mr. Haight have the further advantages which have been pointed out in the article referred to and should show a corresponding higher efficiency. As has been pointed out in that article, the joint designed by Mr. Haight has the advantage that the rim does not need to be hollow.

The laboratories at the Case School have a special apparatus for bursting wheels not to exceed two feet in diameter, and there is now in process of construction another testing plant, where wheels up to four feet in diameter can be burst with safety. I should be glad to have models of the wheels shown in the American Machinist for testing in comparison with a solid rim of the same cross-section. The ever present difficulty in making such tests is that of expense, as such wheels cannot be made in the shops of a technical school without considerable difficulty.

Band or Belt Wheels

Now that the problem of making good joints in the deep rim of the rolling-mill type seems in a fair way to solution, it remains to be seen what can be done with joints in the comparatively shallow and wide rims of fly band wheels. That such joints should be over the arms, instead of midway between them, seems evident. But the wide rim does not lend itself so readily to the treatment accorded the rolling-mill rim. Perhaps the best joint so far devised for this type of rim is that used by the Allis-Chalmers Company, and some other builders of large Corliss engines and shown in Fig. 3. The joint is located directly over the arm and is held together by internal flanges and bolts close to the rim. Pads on the inside of the rim are bolted to similar pads on the ends of the arms and serve to strengthen the joint still further.

Mr. Armstrong, of the Ball engine works, showed me several years ago a novel method of fastening together the two parts of a joint in the rim of a band-wheel. It consisted of a system of diagonally interlacing bolts or studs, something like the laces in a shoe, which came near the center of gravity of the section and held the parts together without the eccentric action of the common flange. It

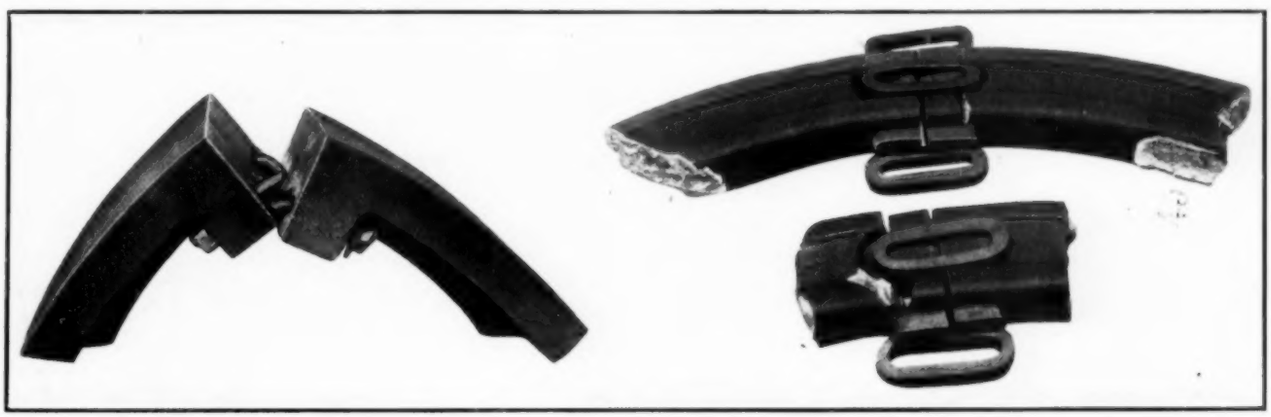


FIG. 1. FLANGED JOINT AFTER BURSTING OF WHEEL

FIG. 2. LINK JOINT AFTER BURSTING OF WHEEL

would be interesting if Mr. Armstrong could be induced to illustrate and describe this joint for the benefit of your readers, and also to make a couple of model wheels to be tested.

Applying the Haight Idea

It seems to me that the Haight idea could be applied successfully to the flat rim in some such manner as shown in Fig. 4. The figure shows a view of the inside of the rim as well as a side view. The wheel rim is channeled on the inside and then reinforced at the joints, where links of steel are let in. The joint can be so proportioned that the metal shall have the same area at all cross-sections.

The rather pessimistic view adopted by Professor Sweet and the Editor has hardly been borne out by the past of fly-wheel design. Ten years ago the common flange joint between the arms was used almost entirely, even by our best builders of large wheels. Since the agitation on this subject among the engineers of the American society, there has been a notable change in this respect, and today the leading engine builders are paying particular attention to the design of this important factor in the strength and safety of a wheel.

C. H. Benjamin.

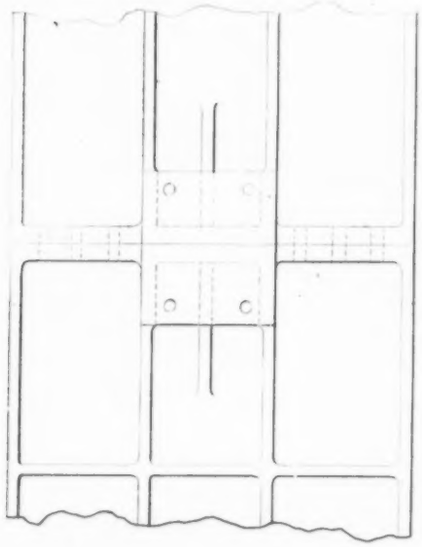


FIG. 3. FLANGED JOINT OVER ARM

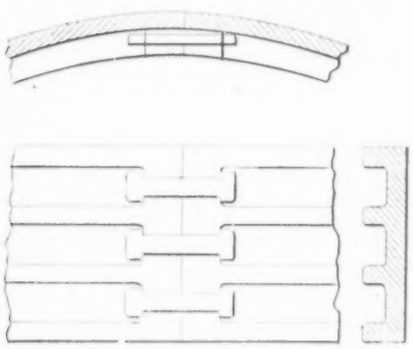


FIG. 4. BENJAMIN'S JOINT FOR WIDE RIM

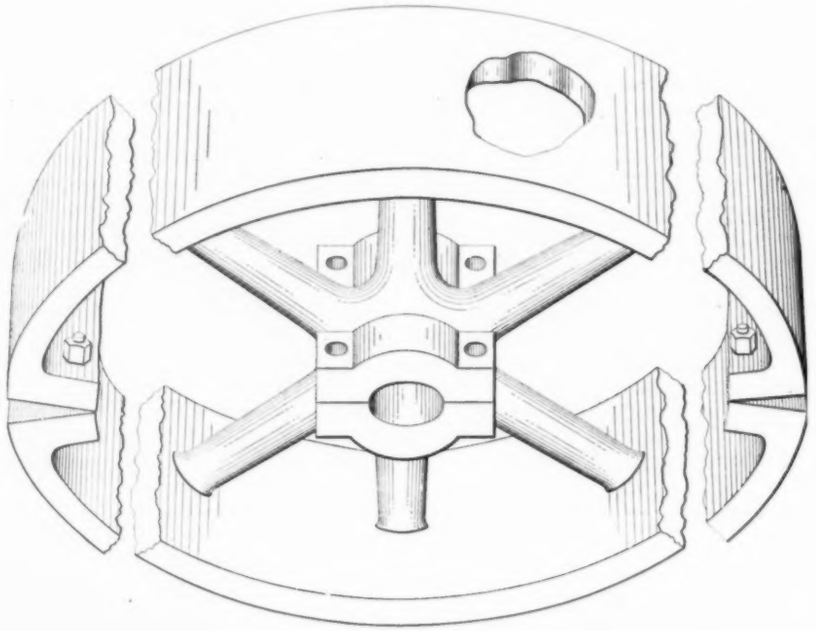


FIG. 5. HOW ONE WHEEL WENT TO PIECES

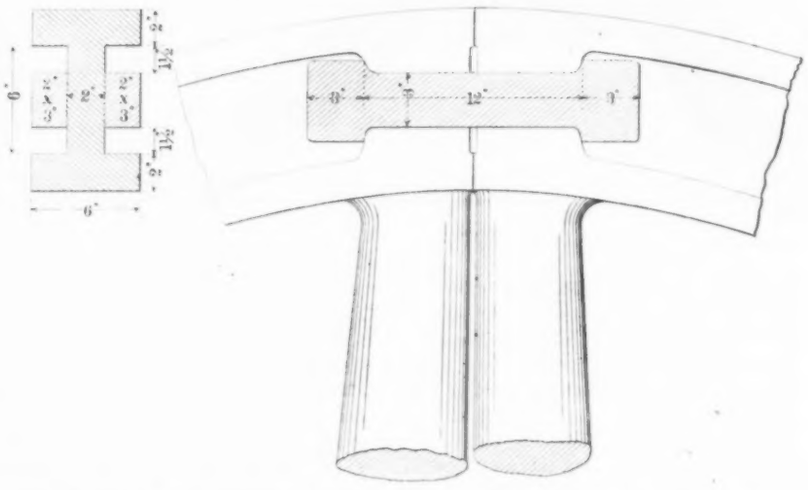


FIG. 6. BOEHM'S SUGGESTION FOR A HAIGHT JOINT OF 100 PER CENT. EFFICIENCY

Is the Haight Joint a Remedy?

An article at page 267 of the American Machinist, describing a fly-wheel rim joint of high efficiency, contains the following:

"The common form of joint used with belt wheels made in halves and consisting of lugs and bolts located midway between the arms is altogether the worst construction of all. William H. Boehm, superintendent of the Fidelity and Casualty Company's department of fly-wheel insurance, concludes after analyzing experiments made by Professor Benjamin of the Case School of Applied Science that this form of joint cannot be so proportioned as to obtain an efficiency greater than 25 per cent. Mr. Boehm has tabulated the efficiencies of various forms of joints and concludes that with those in common use the best efficiency obtainable is 60 per cent.

Fly-wheel rim joints have never received anywhere near the consideration they deserve. Defective fly-wheel castings are peremptorily rejected. But fly-wheel joints of the worst possible design are accepted without comment. No factory owner would accept a fly-wheel having a blow-hole in the rim "as big as a man's hat." But any factory owner will accept without question a fly-wheel having a rim joint that weakens the wheel as much as would a blow-hole big enough to kick a foot ball through it.

A Hole in the Rim

Picture a fly-wheel made in halves, as Fig. 5, and joined together with the usual flanged and bolted rim joint located midway between the spokes. In the rim of this wheel, show a blow-hole of irregular shape and jagged edges extending *three-fourths* of the distance across the face. Now look at this picture earnestly, glancing, if you will, from the blow-hole to the rim joint, then back again to the blow-hole, and you will realize how appalling it is that this rim joint necessarily weakens your wheel just as much as does that immense blow-hole! The truth of this statement is evidenced in the tests made by Professor Benjamin and referred to above. These tests prove beyond question that the maximum possible strength of a joint of the form mentioned is *one-fourth* of the strength of the solid rim.

The reason for the inherent weakness of such a joint is twofold: First, the reduction of the cross-sectional area due to the removal of material by bolt holes; and, second, the centrifugal force due to the weight and speed of the heavy lugs and bolts comprising the joint. This force acts on the rim the same as on a beam loaded in the middle and supported by the ends of adjoining spokes.

A Peculiar Case

The effect on the wheel produced by the centrifugal force of the lugs and bolts is illustrated very clearly in a fly-wheel failure at the Jessup & Moore Paper Company, at Providence, Md.

This wheel was 16 feet in diameter and 31 inches face. It had six arms and weighed 16,000 pounds. It was the type of belt fly-wheel almost universally used on engines of the Corliss type. It was made in halves and had the usual bolted and flanged rim joints located midway between the spokes.

After this wheel had run continuously for some eight years, the two spans containing the rim joints were, without warning and without apparent cause, thrown out and hurled across the engine-room floor. The engine did not race. The rest of the wheel was uninjured and continued to run along as usual until the engine was shut down. The leather belt was torn into fragments, but practically no damage occurred except that due to the loss of the wheel and the belt. Both joints were found intact and firmly bolted together. The bolts were not loose, indicating that they had not been stretched beyond their limit of elasticity.

This was thought to be an exceedingly interesting accident, but what is even more interesting is that about a year later a fly-wheel in the same mill, made by the same builder and running alongside the other, under practically the same conditions, did exactly the same thing. In both instances the two spans containing the rim joints were thrown out at normal speed, leaving the rest of the wheel intact. Both of these accidents were brought about in the following manner:

How They Occurred

When a rim joint came under the belt it was pulled inward by the belt pressure. When the rim joint escaped from the belt, that is, when it came into the open between the tight and slack sides of the belt, it was shoved outward by the centrifugal force of the bolts and lugs.

There occurred, therefore, during each revolution of the wheel, an inward and outward bending of the rim at points near the ends of adjacent spokes. And while the extent of this bending was little it occurred one hundred times per minute or sixty thousand times in a day of ten hours. In eight years in one case and in nine years in the other, this bending action was repeated a sufficient number of times to burst the wheels.

Cast iron, strong in compression, is weak in tension, and the bending action due to the outward thrust of the lugs and bolts exerts a tensile stress on the under side of the rim. Hence failure usually begins by the starting of a minute crack on the under surface of the rim at the points of greatest stress, namely, near the

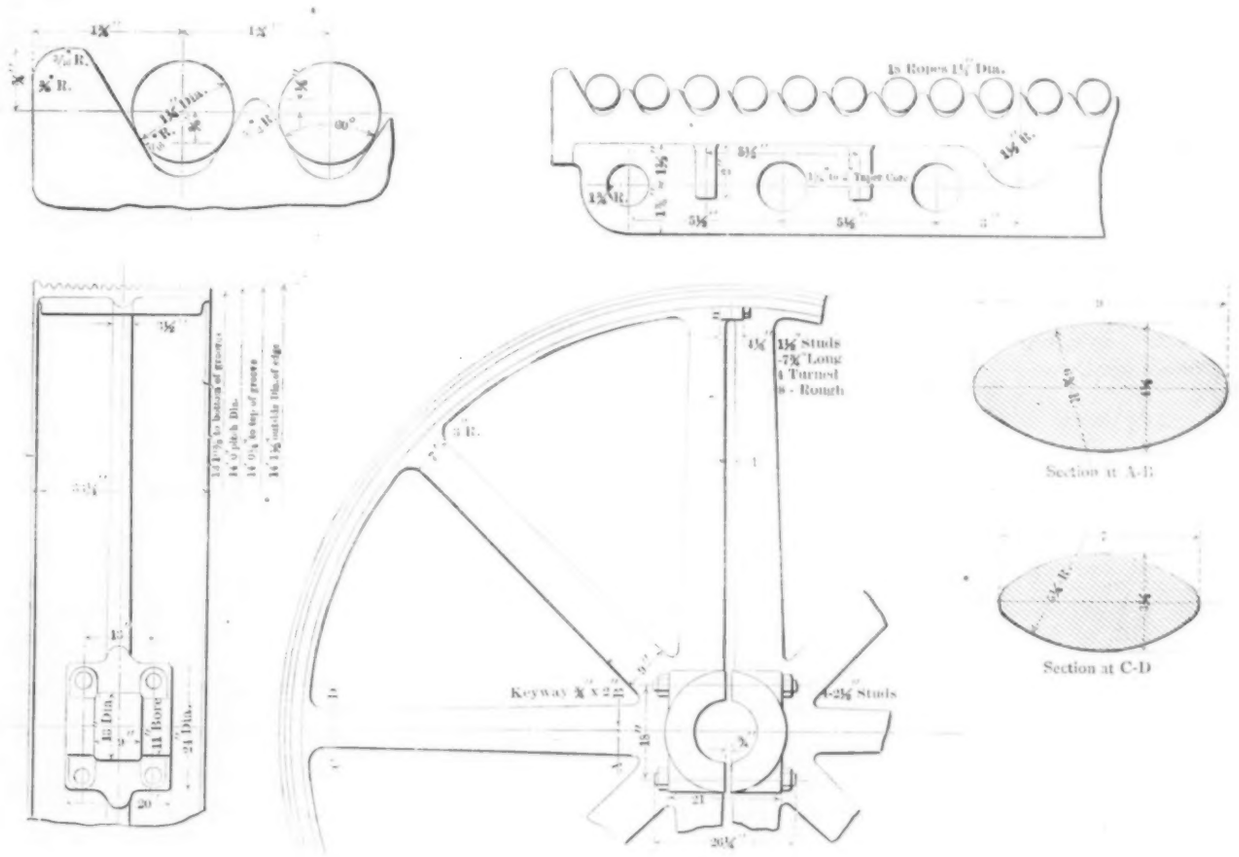


FIG. 7. HAIGHT'S DESIGN FOR A ROPE WHEEL

ends of the spokes adjacent to the rim joint. The cracks gradually deepen until failure occurs with all its disastrous consequences.

These minute cracks are visible to an experienced eye, and careful inspection for these cracks has undoubtedly prevented the loss of many lives and of much valuable property. In several instances where such cracks had begun to show, the engines were being operated with blocked governors. Is there any wonder that disastrous fly-wheel wrecks occur so frequently or that fly-wheel insurance is in such demand?

The danger of explosion is great enough with solid fly-wheels. It is greater with sectional wheels by reason of the inherent weakness of the rim joints. It is, therefore, refreshing to note the prominence given in the columns of the AMERICAN MACHINIST to the "High Efficiency Fly-wheel Joint," recently designed by H. V. Haight, of the Canadian Rand Drill Company. Phenomenal as it may seem, Mr. Haight has evolved a fly-wheel rim joint that may be made fully as strong as the rim of the wheel itself. In other words, it appears feasible with Mr. Haight's device to construct a fly-wheel made in halves or sections that will be fully as strong as if it were all cast in one piece.

THE DESIGN BY MR. FRITZ

This ideal was approached but hardly attained by John Fritz, who some seven years ago designed a heavy rolling-mill fly-wheel having rim joints of high efficiency. Mr. Fritz adopted the expedient of using a rim cored hollow in order to equalize the section. It is our understanding that Mr. Fritz located the joints of his wheel midway between the spokes. If so, the additional weight of the material massed at a joint increased the centrifugal force at that point. This so increased the initial stress in the rim as to render his wheel relatively weaker than would be a wheel cast in one piece without joints.

Mr. Haight has attained the desired ideal by placing the joints of his wheel at the end of the spokes. The centrifugal force due to the additional weight of the heavy joints is by this expedient, directly sustained by the spokes, thus relieving the rim of any additional stress from this source. Then, too, Mr. Haight makes the rim of his wheel "I" section instead of box section, thus greatly simplifying the problems encountered in the foundry.

This joint was evolved for a high-speed water wheel. The efficiency of the joint shown in the original illustration figures about 72 per cent. This is based on the assumption that the cast iron in the wheel has a tensile strength of 20,000 pounds per square inch, and that the steel links have a tensile strength of 60,000 pounds per square inch. Relatively this is as 1 : 3.

A 100 PER CENT. JOINT

In order to determine whether Mr. Haight's rim joint could be so proportioned as to obtain a computed efficiency of 100 per cent., I made the sketch shown in Fig. 6. It will be noted that the area of a section through the rim is just three times the area of the two links in the joint. This makes the resistance of the links $2 \times 2 \times 3 \times 60{,}000 = 720{,}000$ pounds, and of the rim $2 \times 18 \times 20{,}000 = 720{,}000$ pounds. Hence the efficiency of the joint shown figures just 100 per cent.

Whether a segmental wheel using the Haight joint would actually be as strong as a solid wheel without joints can only be determined by a running test in which the speed is gradually increased until rupture occurs. But whether or not such a test is made, it is certain that Mr. Haight has evolved a fly-wheel joint of maximum efficiency. Unfortunately, the joint in its present form cannot be applied to thin-rim belt wheels, but perhaps Mr. Haight will be able to give us a modified form of his joint for this purpose also. He deserves more than passing credit for what he has already accomplished.

W. H. BOEHM.

MR. HAIGHT'S ROPE WHEEL JOINT

[It should not be inferred from the fact that the joint designed by Mr. Haight, and shown at page 267, was for fly-wheels that he has neglected the band or belt-wheel or overlooked its weak points.

He has sent us blue-prints dating back to 1904, of wheels with double arms at the joints and strengthening ribs, as shown in the rope wheel illustrated in Fig. 7.

The leading dimensions are given in the diagram, the ribs between the bolt holes being two inches in depth and four in number. The outer studs are turned to fit the holes, but the inner bolts are left rough and simply bind the halves of the rim together.

The approval of these designs by such well-known engineers should be very gratifying to Mr. Haight.—ED.]

Italy's Industrial Awakening

The news which is coming to this country from Milan is worth consideration. Italy is growing energetic in the pursuit of industries and trade, and unless her people have lost those grand qualities which made them magnificent for centuries as merchants and manufacturers, we shall speedily find them in many markets competing with us and with Englishmen and Germans for mastery of them.

It was a favorite notion of ours, that the big countries, such as the United States, Great Britain, Russia, Brazil, China, would draw enterprising men and capital from the other industrial nations, no matter how wisely these latter might govern themselves or how inventive, diligent and well instructed their people might be. This view met with opposition, and just now our opponents point out that the rapid development in Italy (like the one which has taken place in Germany for some time) will prevent anything like the emigration of bright men from their fatherlands and of capital from them into the big countries.

For a time that will surely be the case. But not forever, and not for very long. If the youth of Italy should turn to manufacturing and to foreign trade, they would probably succeed. That is to say, the average of success accomplished would satisfy the bulk of Italian manufacturers and merchants. But there are always among a people a good many who feel more than the average ambition or more power than they can use in a cramped market. And cramped the Italian or the German market will appear to anyone who realizes the possibilities of a land such as ours or as the British possessions. Then emigration from Europe to us will begin. It will come from the very best elements out of the most developed centers. It may not count up in big figures, but the comparatively few men coming over will have extraordinary abilities. They will be, after some time, leaders in many branches and magnets which will draw capital to the United States from the banks of the strongest centers of activity in Europe.

In medieval times emigrants left countries of high industrial activity as a rule only when oppressed in matters of religion. But then the Hinterland of most trade centers was small and fenced in against foreign immigrants. Perhaps the most recent instance of an emigration of that character was the coming of many hundred thousand Russian Jews to the United States. How quickly these newcomers made a field for themselves in our national work, is well known. But as a rule immigration does not come to us set on the way by impulses given by foreign governments. The character of the industrial immigration to this country will be different and may depend more than we think now upon the ideas and the training of the young men developing Germany and Italy.—*The Manufacturer.*

The demand for flour from China continues, 60,000 sacks having been sold by one company alone. Further telegrams contain an inquiry for all the product of certain grades of flour that can be spared. During March, April, and May all the surplus American flour on the Pacific coast will have been purchased for the Orient, and the demand for China is so great that the buyers are willing to pay extra railway freight rates from Winnipeg to the Pacific coast.

The Pressure on Tools When Cutting Cast Iron*

Important Experiments Giving Practical Data for the Design of Machine Tools of All Classes Using Single-pointed Tools

BY FRED W. TAYLOR

In 1883 in the works of Wm. Sellers & Co., of Philadelphia, a series of experiments was made by Messrs. Wilfred Lewis and John Bancroft with a dynamometer, in which the pressure of the chip upon the lip surface of the tool was measured. These experiments showed that for steels varying greatly in hardness and consequently in their cutting speeds, the variation in the pressure of the chip upon the tool in no way corresponded either to the hardness of the steel or to the speed at which it could be cut. A further study of the results of these experiments indicated also that there was no clearly defined and traceable relation between the tensile strength or the crushing strength of steel and the cutting speed. These results agreed accurately with the observations, which we had made in our many experiments on cutting speeds. Namely, that lathes, boring mills, etc., are able to pull about as heavy cuts with hard as with the soft steels, although there is a very great difference between the cutting speeds of hard and soft steels. Having established this important fact to our satisfaction and having, through these experiments, obtained sufficient data for properly designing machine tools as to the power required to cut metals, no further experiments were made by us in this line until the year 1902, when the subject was again more carefully investigated through dynamometer experiments in the shop of Wm. Sellers & Co. These experiments will be described later in this paper.

Cutting Speed and Pressures of Chip on the Tool Compared for Steel

It is a matter of common knowledge that as the percentages of carbon and manganese increase in steel, the metal grows harder, and that corresponding to this increase of hardness, the cutting speed grows slower and slower. On the other hand, when we compare the tensile strength with the cutting speed, we should expect here also to find that as the tensile strength of the steel increases, the cutting speed diminishes. This is, however, not the case, and a very marked and at first unaccountable irregularity exists between the tensile strength and the cutting speed, although it may be said that in a very general way steels having higher tensile strength tend toward lower cutting speeds.

When we examine, however, the more important subject of the relation of the pressure on the tool to the cutting speed, it is astonishing to note that there is no traceable relation whatever between the two. To a considerable extent also, there is the same lack of agreement between the tensile strength of the steel and the pressure of the chip on the tool.

No law can be established or formulated for cutting steel which expresses either

a the relation between cutting speed and the pressure on the tool; or

b the relation between cutting speed and the tensile and crushing strength of the metal to be cut.

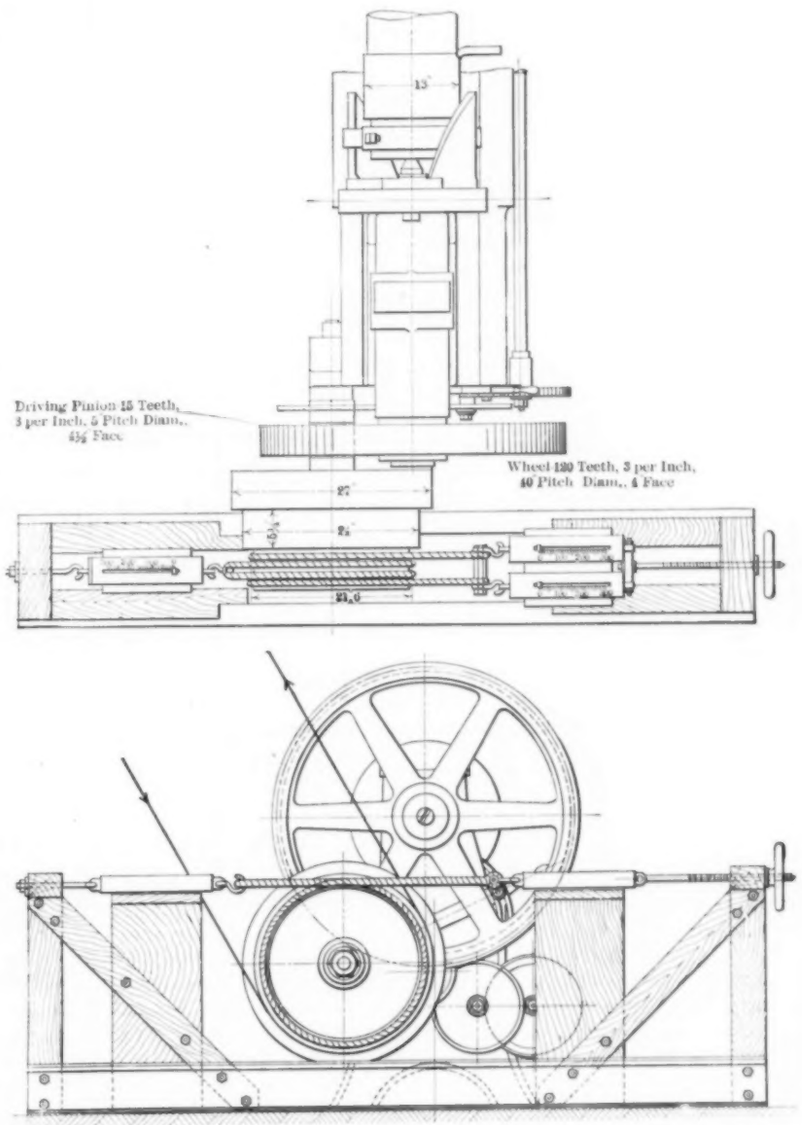


FIG. 1. LATHE USED IN EXPERIMENTS ON THE PRESSURE OF THE CHIP ON THE TOOL

The statistics have the student of this subject in a most chaotic state of mind, and of the many anomalies and surprises met with by experimenters in the art of cutting metals, the most baffling and apparently unaccountable are the following facts:

Apparatus Used and Method of Making Experiments on the Pressure of the Chip on the Tool in Cutting Cast Iron and Steel

Two series of experiments for determining the pressure of the chip on the tool in cutting steel and cast iron have been

*Extract from the presidential address before the American Society of Mechanical Engineers on The Art of Cutting Metals.

SOFT CAST IRON

TENSILE STRENGTH, 12400

CHEMICAL COMPOSITION
Combined Carbon
Graphite
Manganese
Silicon, 1.7 per cent
Phosphorus
Sulphur

HARD CAST IRON
Tensile Strength 24000
Silicon ..... 1.2 per cent

PRESSURE IN POUNDS IN CUTTING SOFT CAST IRON FIGURED BY FORMULA $45{,}000\ D^{\frac{1}{2}} F^{\frac{1}{2}}$
COMPARE THESE PRESSURES WITH THE EXPERIMENTAL PRESSURES IN THE FIRST FOUR COLUMNS OF THIS TABLE

PRESSURE IN POUNDS IN CUTTING HARD CAST IRON FIGURED BY FORMULA $69{,}000\ D^{\frac{1}{2}} F^{\frac{1}{2}}$
COMPARE THESE PRESSURES WITH THE EXPERIMENTAL PRESSURES IN THE FIFTH COLUMN OF THIS TABLE

	½" TOOL SEE FIG. 5				¾" TOOL SEE FIG. 8				¾" TOOL SEE FIG. 8				1¼" TOOL SEE FIG. 5				1" TOOL SEE FIG. 6									
DEPTH OF CUT IN INCHES	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	FEED IN FRACTIONS	FEED IN DECIMALS	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN.	PRESSURE IN POUNDS ON TOOL	PRESSURE IN POUNDS PER SQ. IN
1/8	930	0.0252	592	188000	483	0.0164	475	232000					954	0.0212	337	127000					1/64	0.01562	289	146206	438	224182
	931	0.0320	554	213000	484	0.0286	532	154000					955	0.0328	526	128000					1/32	0.03125	480	122899	736	188445
	932	0.0452	723	128000	485	0.0440	721	141000					956	0.0460	772	134000					3/64	0.04687	651	111092	1000	170342
	933	0.0608	970	127000	486	0.0635	905	114000					957	0.0628	805	102000	1153	0.0640	1430	178000	1/16	0.06250	808	103383	1238	158521
	934	0.0916	1167	102000	487	0.0900	1115	99000					958	0.0908	1019	90000	1154	0.0928	1820	157000	3/32	0.09375	1168	93419	1679	143313
	935	0.1288	1266	79000	488	0.1403	1490	88000					959	0.1292	1315	81000	1155	0.1300	2325	135000	1/8	0.12500	1858	86930	2083	133292
													960	0.1840	1740	77000	1156	0.1850	3166	140000	3/16	0.18750	1764	78604	2825	120826
3/16	936	0.0212	576	145000	489	0.0168	581	184000					961	0.0212	525	132000					1/64	0.01562	417	142379	640	218314
	937	0.0324	914	150000	490	0.0292	581	106000					962	0.0320	881	147000					1/32	0.03125	701	119683	1075	183515
	938	0.0460	1016	118000	491	0.0446	888	106000					963	0.0460	1000	114000	1157	0.0460	1220	141000	3/64	0.04687	951	108184	1458	165889
	939	0.0612	983	86000	492	0.0625	1195	102000					964	0.0628	1355	115000	1158	0.0648	1775	145000	1/16	0.06250	1180	100677	1809	154371
	940	0.0920	1202	69000	493	0.0900	1533	90000					965	0.0908	1642	96000	1159	0.0928	2360	135000	3/32	0.09375	1599	90974	2452	139494
	941	0.1292	1642	67000	494	0.1234	2100	93000					966	0.1292	2115	90000	1160	0.1300	2860	117000	1/8	0.12500	1984	84648	3042	129803
													967	0.1848	2618	75000	1161	0.1815	4070	119000	3/16	0.18750	2690	76503	4124	117304
9/32	942	0.0212	793	132000	512	0.0174	684	139000	469	0.0168	861	182000	968	0.0212	751	126000					1/64	0.01562	609	138511	933	212384
	943	0.0320	1008	112000	511	0.0294	735	88000	470	0.0304	1092	128000	969	0.0320	1135	126000	1162	0.0324	1545	169000	1/32	0.03125	1024	116474	1543	175593
	944	0.0460	1405	108000	510	0.0452	1163	91000	471	0.0444	1360	109000	970	0.0460	1467	113000	1163	0.0460	1925	148000	3/64	0.04687	1364	105266	2127	161377
	945	0.0612	1570	93000	509	0.0625	1317	74000	472	0.0625	1922	109000	971	0.0628	1785	92000	1164	0.0608	2478	144000	1/16	0.06250	1722	97942	2640	150178
	946	0.0900	1883	74000	508	0.0909	1949	76000	473	0.0909	2272	89000	972	0.0912	2205	86000	1165	0.0908	3440	134000	3/32	0.09375	2334	88502	3577	135673
	947	0.1280	2628	72000	507	0.1282	2600	72000	474	0.1270	2870	80000	973	0.1292	2670	82000	1166	0.1250	4485	127000	1/8	0.12500	2893	82294	4437	126215
													974	0.1828	3810	74000	1167	0.1800	5570	110000	3/16	0.18750	3933	74474	5045	141 93
27/64	948	0.0220	1068	117000	501	0.0162	998	146000	463	0.0171	1174	102000	975	0.0212	1052	114000	1168	0.0204	986	114000	1/64	0.01562	889	134817	1363	206720
	949	0.0324	2012	149000	502	0.0264	1260	113000	464	0.0304	1245	97000	976	0.0320	1757	120000	1169	0.0320	2250	166000	1/32	0.03125	1495	113368	2292	173830
	950	0.0460	2068	107000	503	0.0432	1770	92000	465	0.0440	1837	99000	977	0.0460	2088	107000	1170	0.0460	2880	148000	3/64	0.04687	2026	102439	3106	157073
	951	0.0620	2321	88000	504	0.0625	2345	88000	466	0.0625	2220	84000	978	0.0628	2568	91000	1171	0.0608	3740	145000	1/16	0.06250	2514	95330	3854	146173
	952	0.0900	2940	77000	505	0.0926	3200	82000	467	0.0909	3169	83000	979	0.0912	3373	87000	1172	0.0912	4960	128000	3/32	0.09375	3453	86143	5225	132085
	953	0.1327	4240	73000	506	0.1250	3830	72000	468	0.1231	4082	78000	980	0.1292	4108	75000	1173	0.1288	6850	126000	1/8	0.12500	4227	80158	6481	122910
81/128					500	0.0156	1556	157000	457	0.0170	1365	126000	981	0.0212	1984	142000	1174	0.0200	2688	212000	1/64	0.01562	1297	131222	1994	201207
					499	0.0280	2090	117000	458	0.0304	2088	157000	982	0.0320	2245	111000	1175	0.0312	3490	177000	1/32	0.03125	2183	110344	3346	169194
					498	0.0446	3020	107000	459	0.0440	2663	96000	983	0.0452	3164	110000	1176	0.0460	4865	167000	3/64	0.04687	2958	99707	4535	152884
					496	0.0586	4040	109000	460	0.0625	3450	87000	984	0.0640	4022	99000	1177	0.0608	5060	145000	1/16	0.06250	3670	92788	5627	142274
					497	0.0901	5095	89000	461	0.0909	4525	78000	985	0.0900	4744	83000	1178	0.0900	6960	122000	3/32	0.09375	4974	83845	7627	128563
					495	0.1212	6240	81000	462	0.1222	5685	73000									1/8	0.12500	6172	78025	9700	122638
243/256													986	0.0212	2482	123000					1/64	0.01562	1894	127722	2121	195841
													987	0.0320	3260	107000					1/32	0.03125	3189	107437	3568	164736
													988	0.0452	4140	96000					3/64	0.04687	4437	97052	4847	148814
													989	0.0612	5370	92000					1/16	0.06250	5356	90313	6013	138480

TABLE I. PRESSURE ON TOOL WHEN CUTTING CAST IRON WITH STANDARD ROUND-NOSE ROUGHING TOOLS, WITH CLEARANCE ANGLE 6, BACK SLOPE 8 AND SIDE SLOPE 14 DEGREES. CUTTING SPEED ABOUT 60 FEET PER MINUTE

made by us. One set made in 1884, in the Midvale Steel Works, Nicetown, Philadelphia, is of interest only in relation to the power required to feed the tool. The second set was made with greater care and with better appliances in 1902 in the shop of Wm. Sellers & Co., Philadelphia. The latter experiments only will be described in detail.

With the object of warning any future experimenters against the adoption of certain methods in this field, it seems desirable to briefly describe one method which, after trial, proved to be unreliable and was abandoned by us.

A lathe swinging 16 inches diameter over the shears and 13½ inches diameter over the saddle was driven by a 20-horse-power motor using a current of 220 volts, with a belt running directly from the pulley on the motor to the cone pulleys on the lathe. These cone pulleys drove with the following gearing intervening between them and the face plate of the

lathe. Pinion on sleeve of cone pulley: 15 teeth, 3 per inch, 5-inch pitch diameter, 4½-inch face. Wheel on spindle: 120 teeth, 3 per inch, 4-inch pitch diameter, 4-inch face.

Many trials were made to determine the pressure of the chip on the tool by first reading the ammeter while the motor was running without the cut, and then noting the difference in its reading after the tool was cutting, and assuming that the difference in the power used in the two cases was equal to the work done by the tool.

This method proved unsatisfactory, as the fluctuations of the needle of the ammeter were so great under light loads that it was found impracticable to judge with accuracy its average reading. Therefore, as an error in estimating the amperes of current not only directly affects the electrical power expended, but even still more affects the determination of the efficiency of the motor when running under light loads, this method was abandoned as unreliable.

An endeavor was then made to work the motor constantly under a heavier load by attaching an accumulator pump to it in addition to running the experimental lathe. This, however, also proved unsatisfactory, owing to fluctuation in the power of the pump.

Apparatus Used in Experiments on Pressure of Chip on the Tool

The following simple device was then adopted, with which accurate results were obtained and which were repeatedly reduplicated, thus proving at least the uniformity of the whole method.

A rope break was used on one of the steps of the cone pulley of the lathe. This brake, illustrated in Fig. 1, was at that time a somewhat recent improvement on a Prony brake, and consisted merely of a double rope slung around the pulley, having each of its ends attached to spring balances, one of which is stationary and the other of which is attached to the end of a draw screw, which is tightened or loosened by means of a hand wheel whose hub is used as a nut for the screw. The method of experimenting with this apparatus is as follows:

After the tool has been run for a sufficient length of time under cut to bring both the tool and the lathe to what may be called natural conditions as to wear, heat, friction, etc., the reading of the ammeter is noted as accurately as possible while the tool is under pressure. The tool is then removed and the brake is adjusted upon one of the steps of the cone pulley, and tightened until the ammeter reads the same as it did when the tool was under cut. At the same time the readings of the two spring balances are taken; and, since the difference in the readings of the two balances is the effective pull caused by the friction of the brake reduced to the central diameter of the brake rope, by multiplying this pull by the central diameter of the rope and by the ratio of reduction from the cone pulley to the lathe spindle, and then dividing this product by the mean diameter of the forging upon which the cut was taken, the quotient obtained gives the pressure on the tool. In this way all of the power lost through friction throughout the entire apparatus is eliminated, with the exception of the small difference in the frictional resistance of the bearings and gears which lie between the brake and the tool. It will be observed that the difference in the friction of these parts is small between the two cases when, on the one hand, the tool is cutting, and, on the other hand, the brake is tightened. This difference (unmeasured when the brake is on) must be proportional to the pressure on the tool and, therefore, will in no way affect the relative pressures of the different cuts.

It should be noted that it is necessary to take the reading of the ammeter and the two spring balances as soon as practicable after the brake is applied, and before the cone pulleys and ropes become so heated as to cause variation in the frictional resistance of the brake. When this is done, the method is both delicate and accurate.

Details of Experiments upon the Pressure of the Chip on the Tool in Cutting Cast Iron with Our Standard Tools with Various Feeds and Depths of Cut

The following are the general conclusions arrived at on this subject:

(A) Total pressure of chip on tool in cutting cast iron of the different qualities experimented upon by us varies between the low limit of 35 tons (2000 pounds) per square inch sectional area of chip for soft cast iron, when a coarse feed is used, and 99 tons (2000 pounds) per square inch sectional area of chip for hard cast iron, when a fine feed is used. (See Table 1.)

(B) In cutting the same piece of cast iron, the pressure of chip on the tool per square inch sectional area of chip grows considerably greater as the chip becomes thinner, and slightly greater as the cut becomes more shallow in depth. The following are the high and low limits of pressure per square inch of sectional area of the chip when light and heavy cuts are taken on the same piece of cast iron. (See Table 1, column for 1¼-inch tool.)

Depth of cut ⅛ inch × feed 0.0328 inch: Total pressure per square inch sectional area of chip, 128,000 pounds; depth of cut $\frac{7}{64}$ inch × feed 0.1292 inch: Total pressure per square inch sectional area of chip, 75,000 pounds.

(C) The same fact mathematically expressed is that in cutting the same piece of cast iron, the pressure of chip on the tool per square inch sectional area of chip grows greater as the thickness of the chip grows less in proportion to (thickness of the feed) 1 or $F1$.

The pressure of chip per square inch of section also grows greater as the depth of the cut grows less in proportion to (depth cut) $\frac{1}{8}$ or $D\frac{1}{8}$.

(D) The effect upon the pressure of the chip on the tool of a change in the thickness of the feed and the depth of the cut is the same for hard and soft cast iron, and is represented by the same general formula, with a change merely of the constant.

(E) In taking cuts having the same depth and the same feed, the pressure of the chip on the tool, becomes slightly greater the larger the cutting tool that is used. This increase in the pressure follows from the fact that the larger the curve of the cutting edge of the tool the thinner the shaving becomes.

Objects of Experiments on Pressure

The principal object in making the experiments described in detail below was to determine, broadly speaking, the maximum pressures upon the tool per square inch of sectional area of the chip, both in cutting soft and hard cast iron, when our standard shop tools of different sizes were used; this information being needed in designing machine tools. For this purpose the highest pressure of 99 tons (2000 pounds) as indicated in Table 1, should be sufficient.

Our secondary object, and one of almost equal importance, was that of obtaining the pressure on the tool per square inch of sectional area of the chip being cut, corresponding to various changes in the depth of cut and in the thickness of the feed. This information is needed in determining, by means of our slide rules, the exact sized cut which each machine tool is capable of taking under its possible combinations of pulling power, speed and changes in the thickness of feed.

In Table 1, will be seen a summary of the actual pressures obtained under various conditions in these experiments, and in adjoining columns the pressures are reduced to pounds per square inch of sectional area of chip. The same data are recorded in the diagrams, Figs. 2 to 6, by means of round spots which are connected in series one with another by faint lines, so that all of the experiments made with the same depth of cut can be readily compared.

On the left-hand side of each of these diagrams are recorded the regularly increasing pressures of the chip upon the tool; while on the bottom line are recorded the regular increases in the thickness of the feed.

In a series of heavy lines on each diagram are drawn curves corresponding to the following formula, which expresses the general relation existing between the

depth of cut and the feed, and the pressure on the tool for all of the grades of cast iron experimented upon:

$$P = C\,D^{\frac{11}{16}}\,F^{\frac{1}{2}}$$

in which

P = The pressure on the tool;

D = Depth of cut in inches;

F = Feed in inches;

C = A constant depending upon the softness or hardness of the cast iron, and which varies between the limits of 45,000 for soft and 69,000 for hard cast iron, as experimented on by us.

In Fig. 2 are combined all of the various experiments given in detail in the other diagrams. In these diagrams the heavy lines represent the same formula above referred to, while the round spots which are grouped together in series indicate all of the pressures obtained with the various sized tools used and with the different feeds and depths of cut taken in the several sets of experiments.

It will be noted that, on the whole, the law expressed by this formula corresponds very closely to each of the several series of experiments. These experiments were made on different dates, and the pressures were accurately recorded without reference in any case to the data obtained in former experiments. And the fact that they all, on the whole, so closely conform to the same general law, tends greatly toward confirming both the value of the apparatus and of the method employed, and also the accuracy and care of the experimenters.

The conclusion drawn from the Manchester experiments was that the pressure of the chip upon the tool per square inch of sectional area of chip was directly proportional to the area of the chip, and was the same whether light or heavy cuts were taken, and that it did not depend upon either the thickness of the feed or the depth of the cut. This conclusion is at variance with our experiments and with the formula above, which mathematically expresses our results. It may be claimed that the slight difference in the friction of the machine, caused our records to indicate slightly heavier pressures than those actually received by the tool, and that the difference between the results of our experiments and the Manchester experiments can be explained in this way. Unquestionably this slight error in the frictional resistance tends toward recording pressures somewhat higher than the actual pressures; but since the errors are proportional to the pressures, it is evident that it in no way accounts for the relative difference between thick and thin shavings in results obtained by the two sets of experiments. The following data further confirm this reasoning, and also the correctness of our conclusion that the pressure increases as the chip grows thinner.

In the comparison given in Table 2 we have taken the data from two experiments made with the same tool upon the same piece of cast iron. See Table 1.

Depth of cut.	Thickness of feed.	Total section of chip.	Pressure in lb. on tool per sq in. of sectional area of chip.
$\frac{1}{4}$"	0.0916	0.01145	102,000
$\frac{27}{64}$"	0.0220	0.00928	117,000

TABLE 2. COMPARISON OF TWO EXPERIMENTS UPON THE SAME PIECE OF CAST IRON

It will be noted that in both of these experiments chips having approximately the same sectional area were cut, but in one case a thin feed and a deep cut were used; while in the other case a thick feed and a shallow cut were used; and that in spite of the total areas being approximately the same, the thin feed was accompanied by a materially higher pressure per square inch than the thick feed.

In all such instances, it is clear that the frictional error, if any, caused by our apparatus is entirely eliminated as far as it affects thin or thick chips. Many more similar illustrations of this fact can be taken from the data recorded in the tables.

The Manchester experiments do not extend to feeds as fine as those taken in ours, and for this reason it is possible that the results obtained by them were in this particular misleading.

The Effect of the Size of the Standard Tool upon the Pressure of the Chip on the Tool

In Fig. 5 are plotted the pressures obtained in cutting a piece of soft cast iron while using one of our standard 1¼-inch tools. In Fig. 4 are plotted a corresponding series of pressure determinations made upon the same piece of cast iron and using a ½-inch tool. These two sets of experiments were purposely made upon exactly the same piece of cast iron to determine the effect of the size of the nose of the tool upon the pressure. The results very clearly confirm the conclusion given above, namely, that the pressure increases as the thickness of the chip diminishes.

Earlier in the paper we have indicated that in using a large sized tool with a given depth of cut and feed, the chip is thinner than in using a small tool, and that as the depth of cut increases, the difference in the thickness of the chip becomes more marked when taken by a large tool than by a small tool. Now, by referring to Fig. 5, with depth of cut of 27/64-inch, in which a large tool was used, it will be noted that all of the spots lie almost directly upon the line of the curve, whereas, by referring to the corresponding diagram, Fig. 4, for the small tool, it will be seen that these spots lie considerably below the line, thus showing lower pressures corresponding to a greater thickness of chip.

When shallow depths of cut are taken, there is comparatively little difference between the thickness of the chip as taken by the small tool and the large tool, and here it is obvious also that the pressures obtained with the two tools more nearly correspond.

The Effect of a Thin Chip and Shallow Depth of Cut in Increasing the Pressure on the Tool Is the Same for Hard as for Soft Cast Iron

In Figs. 5 and 6 will be noted the actual pressures obtained in experiments, on the one hand, on soft cast iron, and on the other hand, on hard cast iron. These diagrams, together with the formula beneath them, which represents the two sets of experiments, indicate that, generally speaking, the effect upon the pressure of chip on the tool of thinning the shaving and of making the depth of cut shallow is the same for hard as for soft cast iron. The only difference between the two is that the pressures are uniformly higher in cutting hard than in cutting soft cast iron. This fact will be seen in detail by a comparison of the figures in Table 3.

If we select from the table of pressures on the soft cast iron a light and heavy cut, and a similar light and heavy cut from the table for hard cast iron, as in

	Depth of cut in inches.	Thickness of feed in inch's.	Total section of chip in sq. inches.	Pressure in lbs on tool per sq.in. of sectional area of chip.
Soft cast iron	$\frac{1}{4}$	0.0635	0.00785	114,000
	$\frac{27}{128}$	0.0909	0.05695	78,000
Hard cast iron	$\frac{1}{4}$	0.064	0.008	178,000
	$\frac{27}{128}$	0.09	0 05695	122,000

TABLE 3. HARD AND SOFT CAST IRON COMPARED

Table 3 it will be noted that the relative pressure on the chip in the two cases is approximately the same. This is indicated by the following proportion, the figures of which are taken from our tables:

$$\frac{\text{Pressure per sq. in. soft cast iron thin chip (114,000)}}{\text{Pressure p'r sq.in. hard cast iron thin chip (178,000)}} : \frac{\text{Pressure per sq. in. soft cast iron thick chip (7800)}}{\text{Pressure p'r sq.in. hard cast iron thick chip (122,000)}}$$

A comparison of the two formulas given below for soft cast iron and hard cast iron show clearly that the ratio is the same between the two for the different hardnesses of iron.

For soft cast iron $P = 45000\ D^{\frac{11}{16}}\,F^{\frac{1}{2}}$

For hard cast iron $P = 69000\ D^{\frac{11}{16}}\,F^{\frac{1}{2}}$

or

$$\frac{69{,}000\ D^{\frac{11}{16}}\,F^{\frac{1}{2}}}{45{,}000\ D^{\frac{11}{16}}\,F^{\frac{1}{2}}} = 1.533.$$

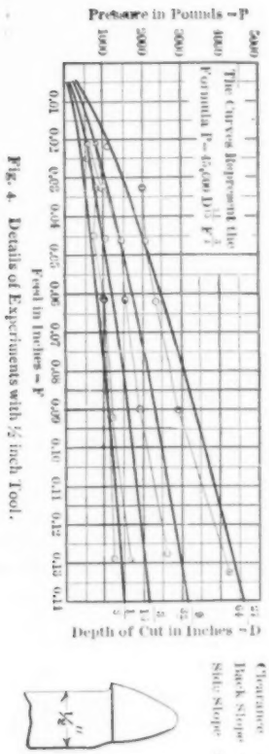

Pressure in Pounds = P
The Curves Represent the Formula P = 45,000 D^1.15 F^0.75
Feed in Inches = F
Depth of Cut in Inches = D
¾"
Clearance 6°
Back Slope 8°
Side Slope 14°

Fig. 4. Details of Experiments with ½ inch Tool.

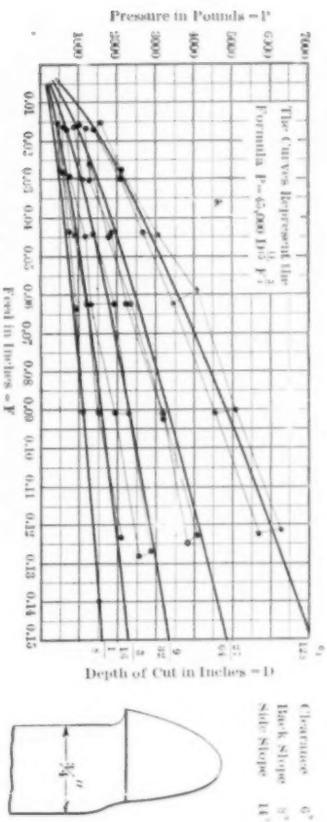

Pressure in Pounds = P
The Curves Represent the Formula P = 45,000 D^1.15 F^0.75
Feed in Inches = F
Depth of Cut in Inches = D
¾"
Clearance 6°
Back Slope 8°
Side Slope 14°

Fig. 3. Details of Experiments with ¾ inch Tool.

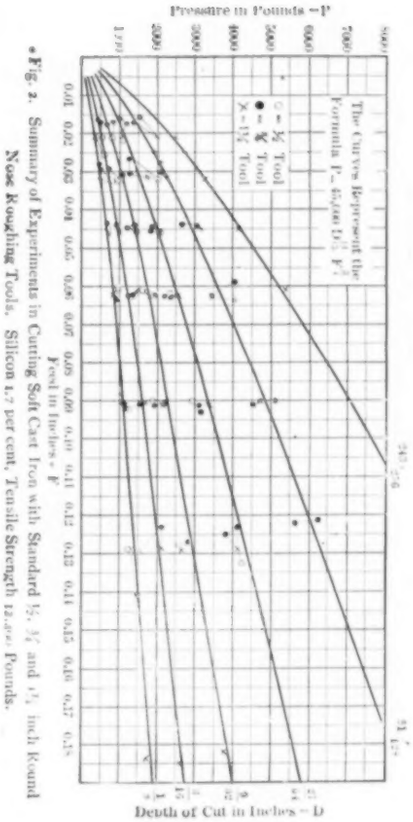
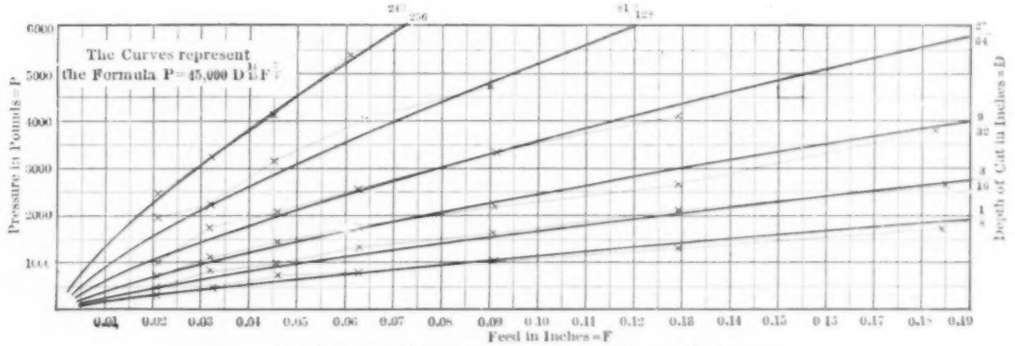

Pressure in Pounds = P
The Curves Represent the Formula P = 45,000 D^1.15 F^0.75
○ = ½ Tool
● = ¾ Tool
× = 1¼ Tool
Feed in Inches = F
Depth of Cut in Inches = D

Fig. 2. Summary of Experiments in Cutting Soft Cast Iron with Standard ½, ¾ and 1¼ inch Round Nose Roughing Tools. Silicon 1.7 per cent, Tensile Strength 22,000 Pounds.



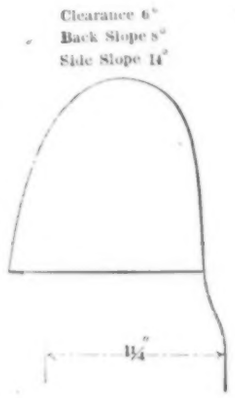
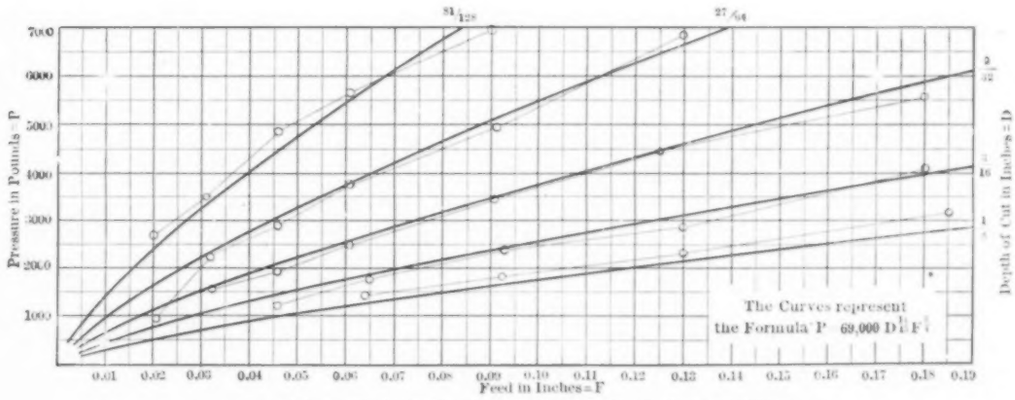


FIG. 5 Details of Experiments with 1¼ inch Tool on Soft Cast Iron



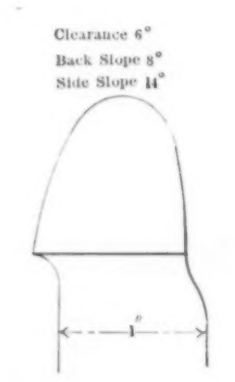


FIG. 6 Details of Experiments with 1 inch Tool on Hard Cast Iron

TAYLOR'S EXPERIMENTS ON THE PRESSURE OF THE CHIP ON THE TOOL IN CUTTING CAST IRON WITH STANDARD ½-, ¾-, 1- and 1¼-INCH ROUND-NOSE ROUGHING TOOLS HAVING CLEARANCE ANGLE 6, BACK SLOPE 8 AND SIDE SLOPE 14 DEGREES

Machine Molding—V*

Mounting on the Molding Machine the Patterns for a Twenty-four Inch Fly-wheel Weighing Two Hundred Pounds

BY G. P. CAMPBELL

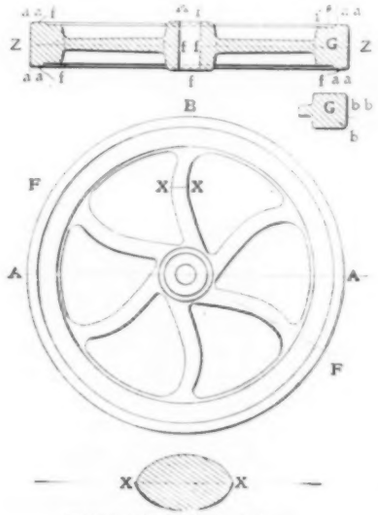
Fly-wheels

The class of machine molding here considered is where all the ramming is done by hand and all the lifting by a hoist.

The Casting to be Made

The casting to be made, shown in Fig. 1, is 24 inches in diameter, 4½ inches face and weighs about 200 pounds. The hole in the hub is to be cored and finished 2¾ inches bore and the wheel is to be keyed on the shaft. The hub is to be finished on both sides, and the rim, also, is to be finished at *a a*. The inside of the top and bottom faces of the rim is recessed at *a*, so that a very light cut across *a a* trues the wheel up, the width at *a a* being only ¾ inch.

These wheels are used for pumping engines and are made in large quantities,



Enlarged Section of Arm.

FIG. 1. THE CASTING

both larger and smaller sizes; 75 pounds being the lightest and 500 pounds the heaviest weight.

Formerly, when these wheels were made on the floor, on a follow board, the parting was made at the center of the rib and rim, and at that time the rim was made as shown at *b b*, Fig. 1, and in truing up it was necessary to turn off the entire face at *b* on both sides, as well as finish the ouside *b b*. The recessing of *a* now does away with much of this turning; this recess is about ¼ inch deep.

The Flask

In making and mounting the pattern on the molding machine, the principal consideration was the producing in the rough casting, as far as was practicable, a true wheel which would not need much finishing. The flask used is shown in Fig. 2, *F F A A* is a top-plan view, the dotted lines showing the outline of the pattern on the molding machine, the arms of the wheel being shown at *f* in the pockets connecting the hub and the rim, while the open spaces *c*, six in number, show vacant spaces for the blocks *E*, which are put in the flask before riddling sand over the pattern or ramming up. This not only saves time in ramming up, but, the bars being closer to the arms of the wheel, it holds the sand more firmly without the use of gaggers.

C shows the nowel part of the flask, the center being cut down, bringing the parting on the inside of the rim and at the hub to the level of the center of the arms; the parting on the outside of the rim is at the bottom of the rim, shown at *j*, Fig. 3.

D shows the flask for the cope. The bars in the middle extend down to meet those of the nowel at *d d;* the parting on the outside is shown at *T*, Fig. 6.

The open spaces for the six blocks *E E* are shown in the sections *C* and *D*, Fig. 2. Trunnions are provided for lifting and are shown at *A A*, Fig. 2. Two pins are put in each half of each flask at opposite corners to fit corresponding holes in the gray iron frame *L* of the molding machine, shown in Fig. 3. These flasks were made to take in different sized wheels from 22 inches to 30 inches in diameter. The bars are ¼ inch thick and 1¼ inches wide.

The Pattern and Mold

In Figs. 1, 3, 4, 5, 6, and 7, the following letters designate the same relative parts in the several views:

- *G.* Rim of wheel.
- *H.* Hub and gray iron arms.
- *I.* Core print.
- *J.* Stool.
- *K.* Stripping plate.
- *L.* Frame of molding machine, gray iron.
- *M.* Pattern plate.
- *n.* Cleat.
- *N.* Draw plate.
- *o.* Machine bolts.
- *OO.* Sliding carriage of molding machine, gray iron.
- *P.* Stool-pipes.
- *Q.* Foundation plate, gray iron.
- *R.* Machine bolts.
- *S.* Smaller part of core print.
- *U.* Stool flange.
- *V.* Hole in draw plate.
- *W.* Segments on stool.

Fig. 3 is a section on line *F F*, Fig. 1, showing nowel pattern on molding machine, pattern up.

Fig. 4. Stool, dotted lines showing gray-iron arms.

Fig. 5. Nowel pattern, pattern down.

Fig. 6. Cope pattern on machine, pattern up.

Fig. 7. Same view, pattern down.

Fig. 8. Section of mold on the line *F F*, showing arms, gates and rim ready for pouring.

Fig. 9 is a section on the line *A A*, showing hub, rim and spaces *c c* between the arms closed ready for pouring.

Stool pipes are of 1-inch pipe threaded right and left hand, and with a hole in

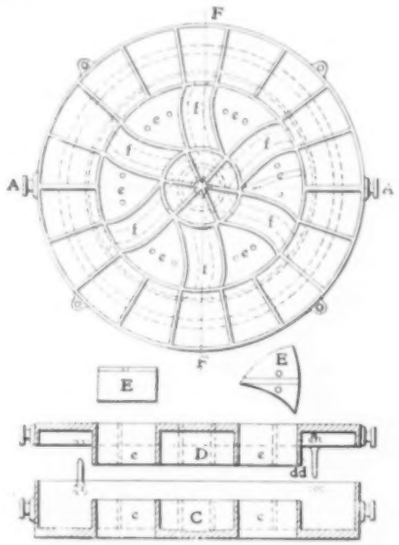


FIG 2. THE FLASK

the middle to adjust hight of stool. The stripping-plate system is used.

Making and Mounting the Pattern—The Stools

The pattern, stripping plates, stools, etc., are made of white pine, faced with hardwood on the top and edges, which are exposed to wear. A separate stool is not provided for each space between the arms, but a stool is made, as shown in Fig. 4, which fits the inside diameter of the rim (one stool for the cope, and one for the nowel); upon this are fastened securely the one-half gray-iron arms in one piece, right and left, a section of which is shown at *X X*, Fig. 1; the hub is of wood, as shown in dotted line in Fig. 4.

*Copyright, 1904. Previous article at page 391, Vol. 28, Part 2.

In making one of these stools it is better to glue it up in strips 3½ or 4 inches wide at the widest point, the grain running lengthwise, as shown by the arrow, with segments glued on both edges, as shown at *W W*, Fig. 4. The whole thing is then turned up in a lathe. The four stool flanges *U* are shown in Fig. 4; flanges are shown in Fig. 3 on foundation plate *Q*, into which pipes are screwed connecting them with those fixed to the stool.

The Pattern

The rim pattern *G* is glued up in segments and turned up in a lathe. The pattern extends ⅜ inch below the stripping plate at *j*, Fig. 3, so the entire outside face of the rim *G*, except the round corner at the top, goes in the nowel, as shown in Fig. 3. The parting on the inside is at the center of the arms and hub *g g*. All parts which are not stripped are made with plenty of draft; this may be noticed on the round of the arm, as shown at *X X*, Fig. 1. A hole the size of core print *I*, is made in the hub and arm casting. This core print is tapered at the top ¼ inch in diameter in both cope and nowel. The core print *I* is made ¼ inch smaller in diameter at *S* to prevent binding, as, when the pattern is drawn downward through the stripping plate *K*, the core print is withdrawn also, as shown in Fig. 5; the bottom of the core print is shouldered where it fits into a hole and is screwed fast to the draw plate *N*.

The Pattern Plates and Stripping Plates

The pattern plates are merely segments planed to an even thickness; their outside diameter is ¼ inch less than that of the rim, their inside diameter ¼ inch more than that of the rim. At *g g* these segments are screwed fast to the pattern; in them, with heads sunk level, are bolts *o* fastening the pattern, pattern plate, etc., to the draw plate *N*; *O O* are the sliding ways of the molding machine, to which the draw plate is fastened by several bolts.

The stripping plate *K* is glued up in three courses of segments, the top one being hardwood, and is all turned in the lathe to fit the molding-machine frame *L*. The pattern should have about 1/16 inch clearance in diameter, must not be too loose, but tight enough so that the sand will be held in place when the pattern is withdrawn, as shown at Fig. 5, leaving a perfect mold. *n n* are cleats on the draw plate to prevent the pattern from rising too high. The holes at *V* are now cut through the draw plate *N* to allow the flanges under the stools to pass through. The latter are located and fastened by four bolts *R* to the foundation plate *Q*.

Fig. 5 shows the nowel paftern on the machine, with the pattern down.

Fig. 6 shows the pattern (in the upper position) and stool for the cope, practi-

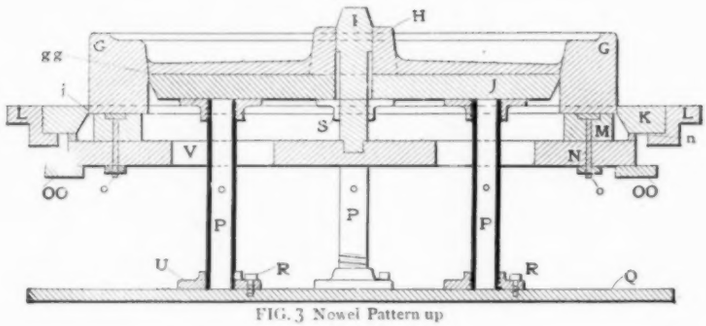


FIG. 3 Nowel Pattern up

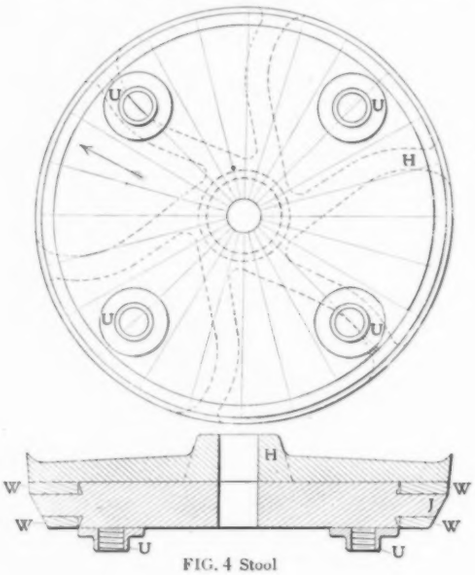


FIG. 4 Stool

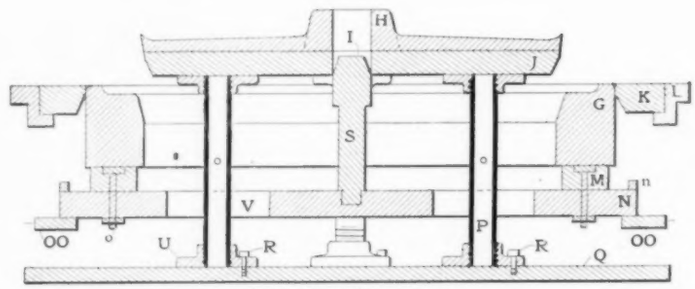


FIG. 5 Nowel Pattern down

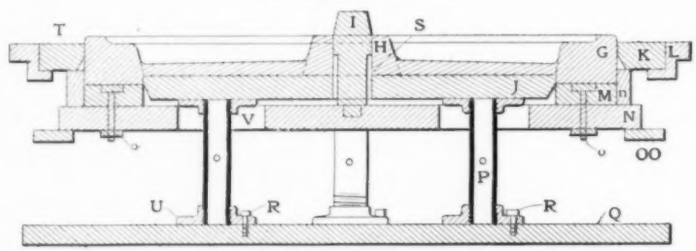


FIG. 6 Cope Pattern up

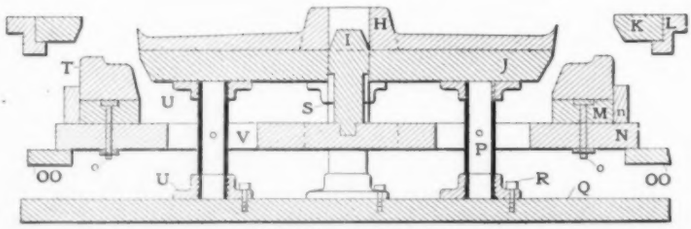


FIG. 7 Cope Pattern down

cally the same as Fig. 3, except the rim is parted at the round of the corner at the top. The cleats *n* are screwed to *M*. The parting on the inside of the rim is the same as in the case of the nowel.

Fig. 7 shows the cope pattern withdrawn through the stripping plate.

The Completed Mold

Fig. 8 shows a section of the mold complete on the line *F F*, Fig. 1, and shows the rim, hubs, arms, gates and the core in position ready for pouring.

Fig. 9 is a section of the completed mold on the line *A A*, Fig. 1, showing the rim, hub and two of the six spaces *e e* between the arms; the trunnions at each side may be seen, and the core in place all ready for pouring.

A Satisfactory Job

The advantages of machine molding over bench or floor work are many; perhaps it would be well to state here that

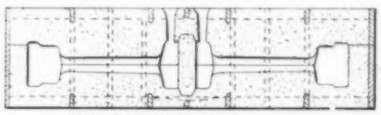


FIG. 8 Mold Ready for Pouring
Section on Line F-F

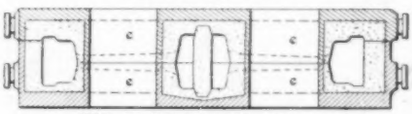


FIG. 9 Mold Ready for Pouring
Section on Line A-A

when these castings were made on the floor it was a rare occurrence to lose a wheel, but there were many other troubles. These castings would always vary from 30 to 60 pounds in weight each and would not be true, to say nothing of the time it took using gaggers and the expense of follow and bottom boards. None of these three things is needed in the machine. Strips of iron are sunk level in the foundry floor, on which the flasks rest.

The use of the boards to cover the pockets *e*, Fig. 2, can only be appreciated by one who has used them. They save much unnecessary labor in ramming, cutting sand and knocking it out again, to say nothing of the floor space it saves, which is no small argument in its favor. No venting is needed on this class of work, except that a wire is put in the core print on both cope and nowel before ramming up and then withdrawn before the pattern is withdrawn through the stripping plate. On smaller wheels of this class separate stools are used in some cases to strip between each pair of arms, but by giving a good draft to the round, as shown in the section *B B*, Fig. 1, this mode has been found to give good results, providing the patterns are mounted correctly on the machine. No finishing of any kind is done on the mold, except that it is blacked. Two men do the work together. Rammers with rubber tips are used to save wear on the patterns.

Steel Cross Ties for Railroads

Since the recent wreck near Johnstown of the Pennsylvania Railroad Company's 18-hour Chicago train, which accident occurred on a section of track equipped with steel cross ties, there seems to be quite a general impression throughout the country that ties made of such material are an entire failure for track purposes. In this connection a communication published in the *Railroad Gazette*, from A. C. Shand, chief engineer of the Pennsylvania system, should be of considerable interest. Mr. Shand calls attention to the fact that he is more than ever impressed with the necessity in the near future of a substitute for wooden ties, and that so far no material has been offered as a substitute that will meet the requirements except metal. He believes that all ties so far tested are somewhat lighter than they ought to be, and also that none of the fastenings for securing the rail to the tie is adequate to the requirements, these points being emphasized in the accident referred to. He continues as follows:

When any suitable fastening shall have been designed, and there is no doubt in my mind that it will be in the near future, either by the Carnegie Steel Company or by someone else, I have not the slightest doubt that the experiments in connection with the steel ties will go forward, not only on this system, but on other leading railroads.

On the Pennsylvania Railroad alone we are using about 4,000,000 cross ties a year, and with the increased price for cross ties in the last five years, and the difficulty in purchasing even at the increased price, it is obvious that some substitute must be secured before long. The quality of the timber also has depreciated enormously in the last five years, so that it becomes imperative that we should either purchase the best cross ties that the market affords and creosote these ties and use heavy tie-plates, or secure a steel cross tie or one of some other composition which will answer the requirements.

This company a number of years ago laid four sections of track with the steel tie as used at that time by some of the English railroads. These were of the inverted trough design, but did not give satisfactory results.

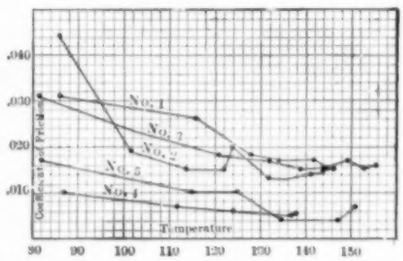
What I am afraid of is that the general public, and the engineering profession in particular, will dismiss the subject of steel ties, as a failure, when in reality they must come sooner or later, and the more intelligent thought given to this matter the sooner a suitable steel tie will be furnished which will be satisfactory in every particular.

Some Tests of Lubricating Oils

By A. L. Westcott

The diagrams herewith submitted show the results of a number of tests of lubricating oils, made by me some time ago.

The machine upon which these tests were made consisted of a shaft running in bearings on a machine frame, and carrying on one end a journal, running in a bearing the two halves of which were pressed together by heavy springs. A lever arm, bolted to the bearing, was supported in a horizontal position at its outer end, on a platform weighing scale. The springs were carefully calibrated, so that the pressure on the bearing was exactly known. A suitable opening was provided in the bearing for the insertion of a thermometer. Oil was applied by means of an ordinary sight-feed oil cup,



SOME TESTS OF LUBRICATING OILS

at the rate of about twelve drops per minute.

The journal was of steel, 3¼ inches in diameter and 8 inches long, and the bearing was of cast iron. The speed, in tests Nos. 1, 2 and 3, was 410 revolutions per minute; in Nos. 4 and 5, 500 revolutions per minute, giving surface velocities of 350 and 425 feet per minute, respectively. The load on journal in all tests, was 1400 pounds, or 54 pounds per square inch of projected area.

The tests were about two hours in length, observations being taken of temperature and scales load every fifteen minutes.

The curves show, in general, a decreasing coefficient of friction with increasing temperature, up to 150 degrees; and the conclusion may be drawn that with the oils tested, that temperature may be safely attained in practice, without danger of seizing.

The sudden rise in curve No. 2, at 122 degrees, was caused by the accidental stopping of the machine at that point. It was immediately started again, and the next observation showed an increase from 0.015 to 0.020; but the following observation dropped back to 0.013. This indicates that, on starting, it takes some time for the film of oil between the bearing surfaces to become reëstablished.

A Large Pit Planer

The accompanying half tones illustrate a pit planer built for finishing the four edges of armor plate 24 feet long by 12 feet wide by 12 inches thick at one setting. The machine was designed to take two cuts ¾ inch deep with 1/16-inch feed in armor plate of 80,000 pounds tensile strength per square inch at a cutting speed of 20 feet per minute, but has ample power for greater cuts, and in fact these cuts have been frequently exceeded.

As will be seen from Fig. 1, the machine has two beds placed parallel to each other, and upon these are two uprights carrying a swiveling cross rail. The latter may be raised so that the bottom of the tool-holders will be 7 feet 2 inches, from the work table or lowered until they are only 10 inches from the table. The cross rail swivels 90 degrees each way from the vertical. The post and rail travel backward and forward on the long beds for longitudinal planing, and one of the two heads traverses on the crossrail for closs planing. In planing longitudinally the heads can be fed in either direction across the rail, and the tool bars fed up or down either vertically or at an angle. When planing transversely the uprights and connecting structure are fed on the bed or the bars up or down in the saddles.

The driving power and traverse movement are secured by 220-volt direct-current Westinghouse motors. The driving motor is a 75 horse-power machine running at from 750 to 1150 revolutions per minute, and gives by means of sliding gears cutting speeds of from 8½ to 20 feet per minute with an equal return speed for cutting in both directions, or a return speed of 27 to 40 feet per minute when cutting in one direction only.

The steel driving screws for traversing the uprights on the beds are 6 inches in diameter, 3 inches pitch. The reversing of the driving screws is accomplished by means of pneumatic clutches under 60 pounds pressure operated by dogs on a revolving disk, one turn of which corresponds to the entire traverse of the machine. By changing the position of a sliding pinion, the same mechanism as is employed for driving the uprights along the bed may be used for driving the right-hand head along the rail. When planing transversely the left-hand head is moved to one side, so that the right-hand head may have the maximum traverse between posts.

The feeds operate either at one or both ends of the stroke. Power for feeding is from a pneumatic cylinder shown in Fig. 2 controlled by a valve which is tripped by dogs on the revolving disk, there being an auxiliary rotary valve for feeding at either one or both ends of the stroke. The feeds of the uprights on the bed and the heads on the cross rail range from 1/32 to ¾ inch. The vertical feed of the bars is from 1/64 to ⅜ inch.

The side beds on which the uprights slide are provided with self-oilers, and are tied together by six sections or cross pieces bolted to their under sides. These cross pieces form the work table. The distance between the vertical faces of the uprights which are tied together at the top by a heavy cross brace, is 25 feet.

The cross rail is very heavily ribbed for resisting the cutting strains and has a 42-inch face, the ends being securely held in saddles sliding on the vertical faces of the uprights. The rail has a 4-foot vertical adjustment by means of a 12-horse-power compound wound motor mounted on top of the cross brace.

The two heads on the cross rail may be swiveled 45 degrees each way from the vertical and have in addition to the power feed across the rail, hand and power adjustments. The sliding tool bars are of steel, of octagon section 15 inches across flats, and the bearings have suitable adjustment for wear. The bars have a 26-inch vertical traverse by hand or by a 3-horse-power motor mounted on each saddle.

There are two kinds of tool-holders, one carrying two tools and used for plan-

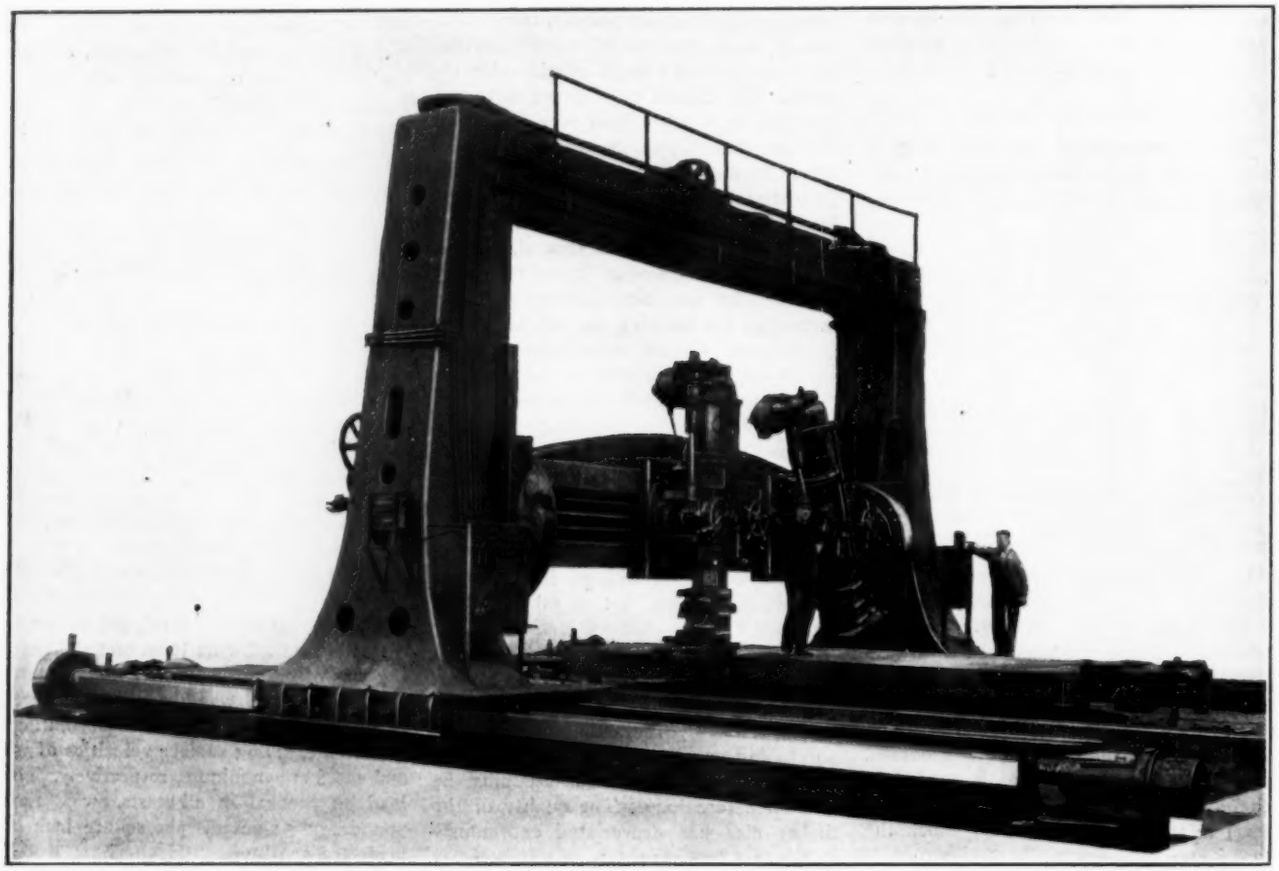


FIG 1. GENERAL VIEW OF PIT PLANER

ing in both directions, the other of the ordinary planer type, for splitting or executing work not readily done with the other style of holder. The aprons and studs of the latter are made to take 6-inch square tool bars.

This machine was built at the Niles plant of the Niles-Bement-Pond Company, New York City.

The Teaching of Foremanship

The method of teaching foremanship at the Pratt Institute is one of the most interesting features of the shops, especially to those who have been through the shop and realize the scarcity of good foremen and the opportunity for good men in this direction.

When the student acquires sufficient practice to enable him to handle any of of the tools in the shop, he has days of being a gang foreman on some of the work under way. This work is the building of tools from castings supplied by the makers, to be used in the shops when completed. At the time of my visit they were building a Stockbridge shaper for this purpose.

On coming in to work the student goes to the board or rack and finds his card, also a check assigning him to a certain tool or job. Perhaps he finds a "Foreman's" check beside his card and instructions as to the work to be done.

First of all he gets the drawings or sketches showing the job, together with the necessary instructions. He never starts a job without these, even if he has to make them himself. Suppose it is feeding mechanism for the table of the shaper.

He goes to the supply department and picks out his stock, such as bevel-gear blanks or castings, bars for screws, castings for the handles, etc. Then he reports as being ready for men, which are supplied him. These are started at work by the gang boss and he then takes a machine himself on this same job, keeping track all the while of the way his men are doing the work. Should he need advice the instructor is always within reach, but he is thrown on his own resources as much as possible and made to take the responsibility so far as he can. This develops h'm in every way and seems to be the only way to bring out the quality necessary in handling men on any kind of a job.

Of course this does not always work out well, as all students are not fitted for foremen any more than all shop men; and we all know many excellent mechanics who do not succeed in directing others. But unless a student succeeds very well he is not graduated, which adds to the value of a diploma or certificate to those who do get through the course with honors, and ought to add to the supply of capable foremen. The training of machinists is one thing and the training of foremen another and very different process; and while many machinists can be trained to make good foremen, this is not done and can hardly be done in the average shop.

From the work done in this course as outlined, an ambitious mechanic can get an idea as to how foremanship is taught and can, if he observes the work in his own shop closely, find many points to watch and information to gather, to fit himself for such a position when the opportunity comes along. And it is well to remember that the opportunity does not come along and wait for you to get ready, but only hits those who are ready and waiting for it to come their way.

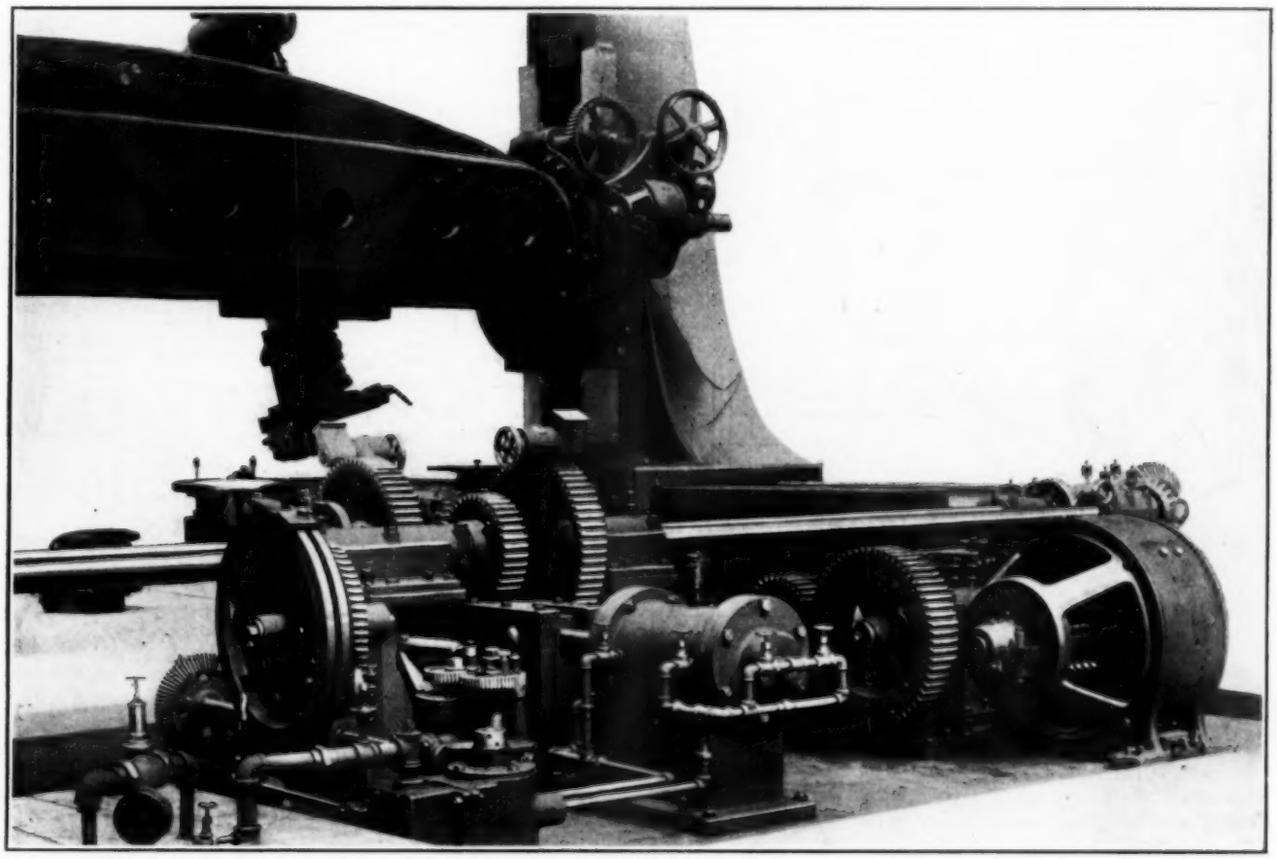


FIG 2. REAR VIEW OF PLANER, SHOWING OPERATING MECHANISM

An exposition for everything relating to paper making, printing, bookbinding, and engraving, to be called the Exposition Internationale du Livre, will be held in Paris from the end of July to October 20, 1907. A special feature will be the production of artistic advertising and post cards.

Cams for Elevator Switch Control

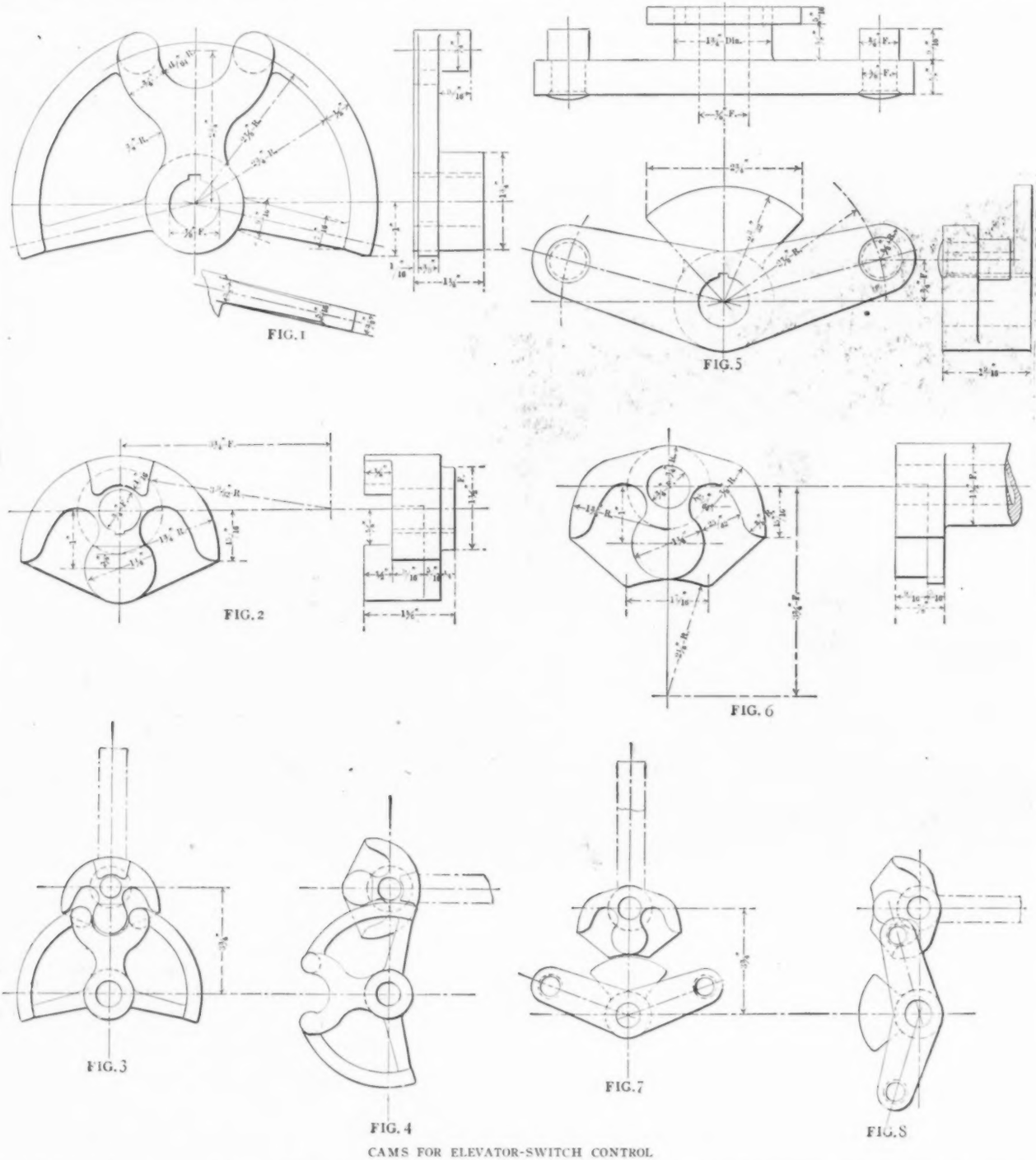
By F. W. C.

Some time ago I was called upon to design a set of switches for elevator control, and to accomplish the desired motions I got out two sets of cams which are different from any I have seen elsewhere, although they may not be new to some of your readers.

The switch had two parallel shafts 3¾ inches apart, the lower one connected to the operating cable and operating the switch blades on the upper one of these cams. There were three blade holders keyed to the upper shaft, that revolved with it, and a fourth, which was the line switch, revolved on it independently. The motion in each case must be very quick, and when not in motion the blades must be locked positively in position.

The cam shown in Fig. 1 was keyed to the lower shaft and Fig. 2 to the blade shaft. Fig. 3 shows this combination in its normal position with blades locked vertically. A movement of 35 degrees of the operating shaft causes it to assume the position shown in Fig. 4, where the blades make contact with a set of clips and remain locked thus, while the lower shaft continues to revolve until it completes an arc of 90 degrees. This motion is the same on each side of the normal or vertical position as one set of contacts is for going up and one for going down.

Fig. 5 is keyed to the operating shaft, but Fig. 6 revolves freely on the blade shaft and carries the line switch blade on a special holder, which is not shown. Fig. 7 shows this combination in normal position, with blades locked vertically, where it remains until the last 35 degrees travel



CAMS FOR ELEVATOR-SWITCH CONTROL

of the operating shaft causes it to take the position shown in Fig. 8. The first return motion of the operating shaft breaks the line, and just before it reaches the normal the other contacts are broken.

These cams worked easily and smoothly, and gave perfect satisfaction under the trying conditions which elevator work imposes.

Some Engine-lathe Details

By Racquet

Recently it fell to my lot to design a 9-inch center 18-inch swing high-speed lathe, and thinking some of your readers may be interested in the machine, I herewith present some of the details. I might say that some of the parts of this lathe are subject for patents, yet I shall gladly welcome any criticism.

The Bed

Fig. 1 shows the section of the bed, and for comparison an ordinary English lathe-bed section is shown in Fig. 2, the latter being very similar with regard to the leading dimensions. It will be seen that the latter, which is from actual practice, is practically cut half-way through depthways, the box partitions having to be made low enough down to clear the holding down plates of the tailstock. Compare this and the ribbed section of Fig. 2 with the ⊥ groove and complete box section of Fig. 1. It would be possible to make Fig. 2 stronger with very little extra cost, but it would be impossible in my opinion to distribute the metal to better advantage than in Fig. 1. The strip of metal at the front of the bed *A*, will, of course, be recognized as a guiding strip for the carriage, which practically eliminates the twist, aptly called by Professor Sweet "the bureau-drawer action." This guiding-strip principle was shown and described twenty years ago by Rose in his "Modern Machine-shop Practice," and has lately been revived by Lang & Sons, the Glasgow lathe manufacturers.

In my opinion this is one of the neatest improvements introduced into lathes for some considerable time; and it seems a great pity to me that so good an idea should have lain dormant all this time, though I believe one of your American lathemakers who introduced a similar idea had to abandon it, because his customers thought they were being "got-at."

One of Professor Sweet's axioms is that "anything that does not tend to wear out of true will keep true indefinitely," and there can be no questioning the fact that this guiding-strip principle applied to a lathe carriage as in Fig. 1, nearly eliminates all tendency to wear out of true.

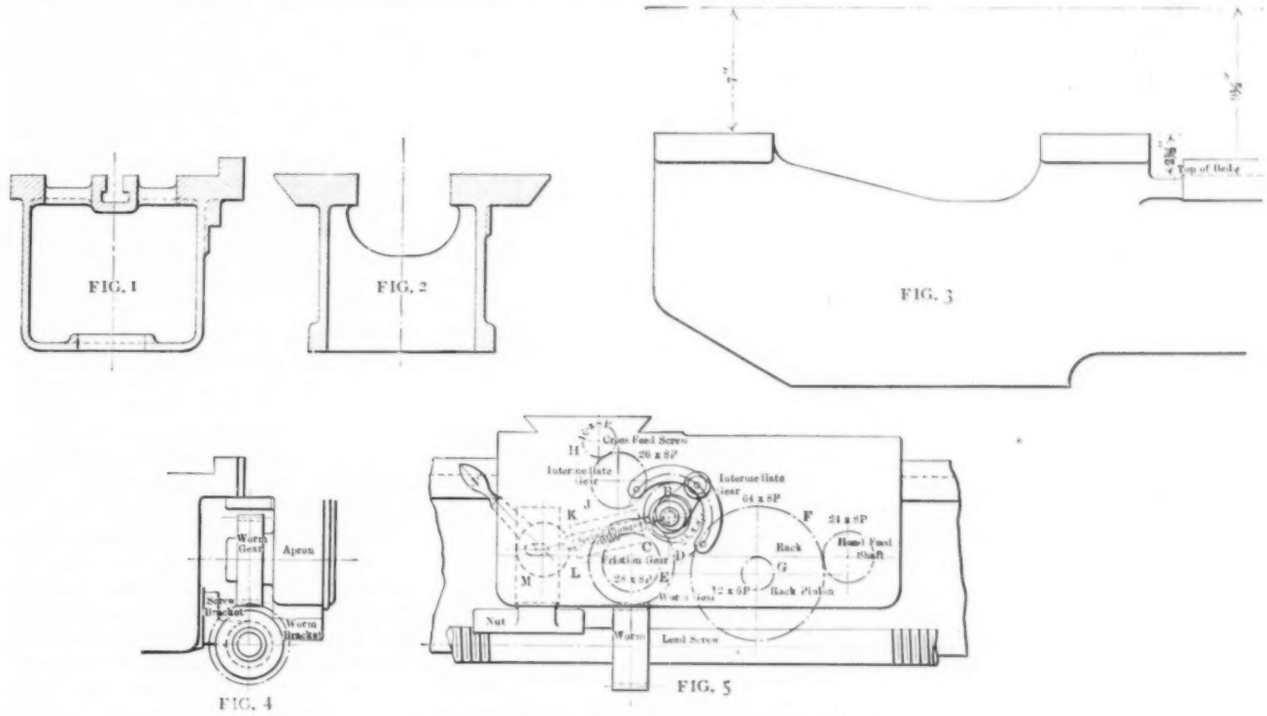
The Headstock

Fig. 3 shows another idea which to some extent is an old one renovated. Some high-speed lathemakers believe in making headstocks which are bellied out both sideways and downward to an enormous extent, so that the large cones employed may clear. This to my mind not only produces an unsightly headstock, but also one that is not as stiff as it ought to be. I think that the connecting pieces between the front and rear bearings being necessarily weak or else very cumbersome, it is better to cast the bearings separately, and make sure that each of them is firmly secured to the bed.

My method of doing this is shown in Fig. 3. The surface to which the spindle bearings are bolted is raised above the level of the bed, in this particular instance 2½ inches, so that the spindle bearings are short, stiff castings. The hight of the centers is 9½ inches, and the headstock part of the bed being 2½ inches higher than the top of the bed proper, the hight of the center of the spindle bearings is only 7 inches. I might say that the largest cone step is 18 inches diameter.

A Lead-screw Detail

Fig. 4 illustrates a little idea which would be unnecessary if the machines were built strictly interchangeable; but unfortunately we have not yet reached that desirable state of things, so that we have to try our best to reap the benefits of interchangeable manufacture without the trouble and expense of making the necessary jigs and fixtures, which I fancy in this instance would be a trifle intricate. I refer to the machining of the lead-screw brackets on the bed and the worm bracket on the carriage. The feed-worm gear is a straight-faced one, so that the worm will mesh equally well at any part of the width. The brackets for supporting the lead-screw bolt on to a *vertical* seating on the bed; the worm bracket, which also supports the lead-screw, bolts on to a *horizontal* seating on the under side of the apron, so that, when setting, the brackets may be moved to accommodate each other; that is, the worm bracket on the carriage being a fixed hight from the top



DETAILS OF BED, HEADSTOCK AND CARRIAGE APRON

of the bed, the lead-screw brackets must be adjusted vertically till they are in alinement. The brackets may be machined up in quantities, which to the best of my knowledge is one of the leading features of the interchangeable system. The lead-screw nut is fitted when the screw brackets have all been fixed.

The Apron Gearing

Fig. 5 is a diagrammatic sketch of the apron feed gear. The worm is splined to the lead screw and drives the worm gear, shown also in Fig. 4. To this is clamped by a hand friction the 28x8*P* gear *E*. The 28x8*P* intermediate *D* is mounted on an eccentric *A* controlled by the small lever *B*. The eccentric is so arranged that when the lever *B* is in the bottom position the intermediate *D* meshes with the friction gear *E* and the gear *F*, which is fixed to the rack pinion *G*, so that if the friction gear *E* is clamped to the worm gear, the carriage will travel along the bed. If the lever *B* is moved round to the top, gear *D* connects friction gear *E* to the cross-feed screw pinion *H*, through the intermediate *J*. The clamping of the same friction as before will now put into operation the cross feed. It will be seen that it is impossible to have both cross and length feeds engaged at the same time.

To the inside of the apron cover is fastened a small slide *K* carrying a flat plunger *L* having a 90-degree point at each end. The plunger is pressed into a notch cut into the cam *M* by a small spring. The cam *M* is for engaging the nut with the lead screw. The eccentric *A* has mounted on it a disk *C*, into which is also cut a notch. Now if the lever *B* is in the position shown (that is, all the feed gears inoperative), the lead-screw nut may be engaged by depressing the handle *N*, the spring plunger being forced up into the notch in *C* so that lever *B* is locked central.

If lever *B* is in either top or bottom positions, it is impossible to press down handle *N*, because the right-hand point of the plunger *L* is against the periphery of disk *C*. It must be understood that the friction gear *E* must be clamped to start the feed after the desired gear train has been put into operation by lever *B*; also, if lever *B* is central, as shown, it is immaterial whether the friction is engaged or not, because both cross- and length-feed gear trains are disconnected.

Pig-iron importations show a marked increase, despite the fact that the production of pig iron in the United States in 1906 was far in excess of that of any earlier year. The total importation of that article in the seven months ending with January last was 283,000 tons, valued at 8⅓ million dollars, against 150,000 tons, valued at 3½ million dollars, in the corresponding months of the preceding year.

Sammy's Shop—Trying to Put Things on a Permanent Basis

By W. Osborne

Time had passed and Sammy was not as young as he had been when he first undertook to run a shop. He had prospered to the extent that he did a lot of work and gave steady employment to over fifty men. He dressed well and lived comfortably, and his credit was good at the bank.

One day he had a visitor who came rushing in to see him on a matter of business, and who seemed to be in great haste to get away again. He was a man of about Sammy's age, and had started in business a score or more years before in a neighboring city. A man of means had furnished capital, and he had furnished the experience, and from a modest beginning had been built up a business of considerable size, and one that was supposed to be profitable to the owners.

A Friendly Chat

"You might as well stay long enough to have a friendly visit," said Sammy, as they concluded the business. "That shop of yours will be there when you get back. Imagine you are having a vacation for an hour or so."

"Vacation! I wish I had the kind of a business that would allow a man to have a vacation once in a while. I have been away for pleasure only three days in 20 years. I took a trip to the mountains once, but thinking of all the pesky ways they have of getting into trouble in the shop drove me back again, and I have never tried it since."

"I suppose then that you are working for the time that you will have enough laid by so that you can retire and let someone else do the worrying."

A Pessimist

The other man laughed in a sarcastic, bitter way. "Did you ever know of a man in our business who had to start with nothing, as we did, and who retired of his own accord? Either the sheriff gets us or we drop in the harness." To prove this he named over a number who had gone one way or the other, and a number more who were so old that if they were ever going to retire they would have to do it very quickly. "No sir! I tell you it is a lot easier to get in than it is to get out, unless you are forced out because you cannot hold your own against the odds. I'll bet that you often feel poorer right now than you did when you were running a lathe like you were when I first knew you. I know that I do. Judging by the figures on the paper we have been making money, but where is it? To carry on the business this year we have over $65,000 tied up in one kind of stock alone. To buy it right we had to pay cash, and it took quite a lot of working with the banks to get the money. A man may be making money, but he gets it tied up so awfully tight in stock and manufactured goods and accounts that if he does not keep a close watch he will find that he can lose it a great deal faster than he ever made it, and I guess you know all that as well as I do."

The Drive of Business

"Well, you are nothing, then, but a very hard-worked hired man who is working for his board and clothes. You dress well, but you hardly have time to eat; and you work all the time when you are not asleep. You haven't even time to make a friendly call on your friends. If you die, your interest in the business will not do your family any more good than life insurance would and maybe not so much, for it may go to smash without you to look after it, and the only fun you have is the fun of seeing how much harder you can work than any man you have ever been able to hire."

"You've hit the nail on the head; but how much better off are you, and furthermore, what are you going to do about it?"

The friends parted, but the question remained with Sammy:

"What are you going to do about it?"

Useful Foremen

In one way he was in much better shape than the other man. Early in the game he had seen that to get along he must have others to carry some of the load. He had a foreman for each department, and when a man was put in as a foreman he was given real authority and made to understand that he had a burden that he must shoulder if he kept the job. There was no "straw boss" business about it. It did not matter how few men a foreman might have under his direction, the business with them must be done through him and not over his head; and his men were given to understand that they were responsible to him and to nobody else, and that if they could not suit him they were not wanted. Each foreman was given to understand that it was part of his duty to work in harmony with every other foreman in the place just as much as it was the duty of each one of his men to work harmoniously with each of his fellow workmen. If work came out wrong Sammy would "go after" the foreman, and might find out who did the bad work and how it came to be done; but if planning could have prevented it, that was a part of the foreman's job.

This system of shop management made it so that Sammy could be away for a short time almost any time, and the business would go on just the same; at the same time he had to decide all questions as to the general management.

A Stock Company Formed

After much thought he began to sound certain of the men who had made his interests their own as to their willingness and ability to become a part of the business with him. They all had the willingness, but most of them thought that they lacked the ability to put in the necessary amount of money. The matter was talked over for some time, and the final outcome was that a stock company was formed. Each of these men was given the chance to buy a certain amount of the stock. One man had been thrifty enough to have money, and paid cash for his. The bookkeeper, with his business training, did not have any trouble in raising the amount that he lacked to pay for his share. Another man mortgaged his home to pay for part of his, and gave Sammy his note for the balance. It looked for a while as though there was one desirable man who would have to be left out.

A Good Workman's Opportunity

He was a good, sober, industrious fellow who had been brought up by parents who had gone on the theory that it was as cheap to rent as it was to own, and that no matter how saving a family might be, if a man had to work for day wages he could never get far enough ahead to make it worth while. He had simply followed along with the same ideas, and while he had kept even he had not gotten ahead. The more he had been able to earn the more they spent, and aside from a very moderate life insurance he had not made any provision for the future of his family.

This chance came as a surprise to him. "I never expected to get a chance like this in the world, and I do not see how I can take it now that it is here."

Sammy's Offer Accepted

"Suppose that I give you a chance to buy it as fast as you can. How will that suit you? If you can't buy any of it, you will not be any worse off than you are now; and if you are able to buy some of it, you may do so." That arrangement was made, and the man was surprised to find how fast he could save money when he had an object in view.

The results that came to the business from this new combination were altogether different from those which came from the first one. These men were all trained to do their parts in the business that they were engaged in. Each one understood his own part thoroughly and enough of that of each of the others to give them full credit for it, and they got along well together.

A Better Location is Secured

One thing had given Sammy considerable worry and anxiety, and that was the immediate surroundings. He knew and had suffered somewhat from the danger from a fire on his own premises, but he felt that it was in his own hand to safeguard against that to a considerable extent. With the risk that came to him from the surrounding establishments it was not in his power to provide much of a safeguard. Another matter also began to press. They lacked room on their own land for further expansion. In their favor it so happened that their next-door neighbor also needed room to grow, and they sold out to him and moved to another location. This time they bought more land than they thought they would perhaps ever want for buildings, but as it would at least serve to keep others some distance away it seemed the wise thing to do.

They are still growing along just as they always did. They do not have any advantages that do not come from hard, honest, careful work and a thorough knowledge of the business, and of the people they serve. It is not a large business even now, as viewed in dollars, but to the man who works steadily there it is just as important as though thousands worked with him instead of scores.

Some Things to Consider

Perhaps some of you would like to know where this shop is, so that you may be able to take a look at it. I do not think that there is one of you so far from civilization but that within a reasonable distance you can find a shop that will have enough of the ear marks to serve as a sample. Don't go to thinking about the one that is going (according to the accounts of the daily newspapers) to revolutionize the mechanical world, and for fear of landing you in the poorhouse is willing to let you have a little stock out of pure milk of human kindness. Don't think of the one that is trying to milk the Board of Trade and the city fathers before they will give your locality their consideration. Think of the modest establishment where Tom and Bill and Mike and some of the rest of the boys who want steady work have been working, some of them for 20 years, and which the local paper takes so much as a matter of course that it never thinks to praise it except at so much an inch, and which the tax assessor "soaks" just as he does the mechanic's home. If you do not hit this identical shop you will hit one near enough like it to be a brother, if not a twin, so that it will be all right. It may be that you are working in one of them, or else you are one of the stockholders.

The Japanese legation has sent word to the Brazilian minister of foreign affairs that there will shortly arrive in Rio de Janeiro a large liner, belonging to a Japanese shipping company, which is fitted up as a floating exhibition of Japanese products, says the *Brazilian Review*.

Alcohol and Acetylene Together as a Fuel for Internal-combustion Engines

The presence of water in alcohol ordinarily has a tendency to reduce its combustibility and efficiency when used as a fuel in an internal-combustion engine; nevertheless, exactly the opposite result is attained in the process of F. W. Barker and T. L. White, described in *The Automobile*, so that the more water there is, within certain limits, the more readily the combustion takes place. This result is effected by causing the alcohol to be sprayed over calcium carbide before entering the engine cylinder (in the experiments a 3½-horse-power De Dion), so that the water acts on the carbide and generates acetylene. Thus the water is gotten rid of, and the resulting mixture, called by the inventors "alkoethine," is a compromise between the explosive acetylene and the more sluggish alcohol; it is found that good results are obtained with alcohol having about 19 per cent. of water, an indicator card being produced quite similar to that of gasolene. Another advantage is that there is not the production of acetic acid, which attends the use of alcohol by itself, and which is so injurious to the metal of the engine. Of course the calcium carbide adds to the cost of the fuel, but on the other hand the alcohol is cheaper, being more dilute.

Tokio Underground Railway

The *Bulletin Commercial* has received from the Belgian legation in Tokio particulars of a scheme to construct across Tokio an underground railway. The distance is about 12 miles, and the cost is estimated as low as $625,000 a mile. A company is to be formed with a capital of $7,500,000. It is expected that a uniform fare of 2½ cents will produce a dividend of 8 1/5 per cent. The *Commercial* adds that as soon as the scheme became known other towns in Japan desired that plans for similar undertakings should be prepared for them. The Electric Tramway Company of Tokio has asked for sanction to extend its system by the construction of an addition of 60 miles.

Acording to *Nature* the absolutely highest reading of the barometer on record is 31.72 inches, which occurred at Irkutsk on December 20, 1896, and at Semipalatinsk on December 16, 1877. The highest in the British islands is 31.11 inches at Aberdeen on January 31, 1902, and 31.10 inches at Fort William on January 9, 1896. The lowest reading on record at the surface of the earth, and reduced to sea level, is 27.12 inches at False Point, on the coast of Orissa, on September 22, 1885, and the lowest in the British islands 27.33 inches at Ochtertyre on January 26, 1884.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Uniform Compression Space in Gasolene-engine Cylinders

As the design of multiple-cylinder engines for automobile service becomes better understood, and their use more general, the demand for smoothly running engines has increased. This is causing some manufacturers to devote more attention to uniform compression in the different cylinders. Unless the entire combustion space is accurately machined, which is usually impracticable owing to the valve and igniter cavities, there is liable to be enough variation in the cylinder castings so that the power developed in the different cylinders varies to a noticeable extent.

During recent tests on some medium-sized four-cylinder engines the fact was brought out that this variation in compression space may be several cubic inches among cylinders in the same engine.

When one considers that the explosive power is perhaps roughly four times the compression, as registered by a gage, it is not difficult to see that this variation should be guarded against.

A convenient way to overcome the difficulty is to design some of the inserted parts, such as the cylinder-valve plugs, so that more or less of the surplus metal may be machined off as required, as indicated by the dotted line in Fig. 1.

To avoid unnecessary fitting on the engine-assembling floor, several varieties of the plugs, taking up more or less of the compression space, may be machined and used as found necessary. Probably a limit of one-half cubic inch less or more than the normal capacity would be permissible.

For testing, a simple fixure like Fig. 2 will be found advantageous. This may consist of a flat plate *A*, on which is mounted a dummy piston *B* of such length that when the cylinder *C* to be tested is set down over it and on the plate, the top of the piston is in the proper relation to the top of the cylinder for the end of the compression stroke. A carefully measured amount of liquid, corresponding to the cubical contents of the compression space desired, may then be poured in through a funnel screwed into the plug hole in the top of the cylinder, and the plug adjusted until the liquid just fills the compression space. A single ring near the top of the dummy piston, if smeared with oil or vaseline, will prevent the liquid from leaking past it.

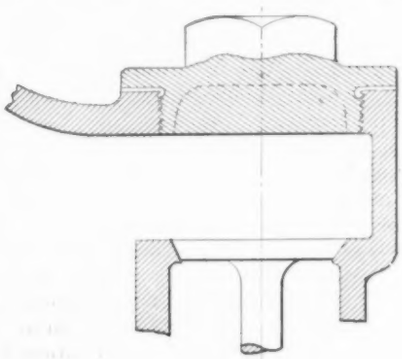


FIG. 1

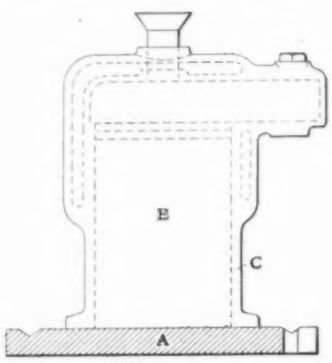


FIG. 2

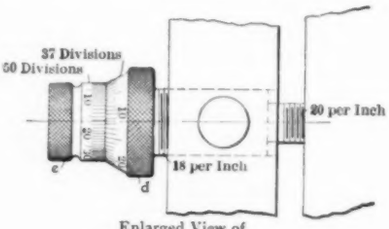
UNIFORM COMPRESSION SPACE IN GASOLENE-ENGINE CYLINDERS

As water tends to rust the cylinders, a thin oil or gasolene is best to use for a testing fluid. E. J. BARTLETT.

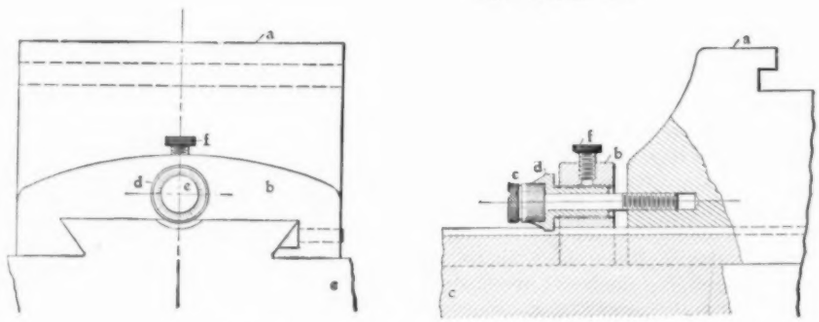
Fine Adjustment of Tool Block

I have frequently had trouble on engine lathes, when screw-cutting, in getting a nice, smooth finish on the thread. This I have attributed to not being able to get a fine adjustment on the stop used to feed the tool in to the work. On most of the standard lathes this stop is arranged as a block which is clamped on to the slide of the slide rest, and has a small nurled-head screw passing through into the tool slide. This screw in every case has a head about 5/8 inch diameter, and is usually about 3/8 inch diameter, standard thread, on the body.

Now, I ask, is it possible to get a very fine adjustment with a screw like that, which is adjusted with the thumb and one finger, by guesswork? It is absolutely necessary to get adjustments of 0.001 or less when screw-cutting, especially when cutting large threads, on account of the large cutting edge of a thread tool.



Enlarged View of Adjusting Screw Dials



FINE ADJUSTMENT OF TOOL BLOCK FOR THREAD CUTTING

GETTING A FINE ADJUSTMENT

To overcome this defect I have fitted a stop on one lathe, a 14-inch Reed, as per sketch, and find it works much more satisfactorily than the old stop, inasmuch as I can get adjustments as fine as 0.0005.

The lathe slide rest is shown at *c; a* is the tool slide and *b* is the block clamped to the slide rest. Into this block is screwed a bush *d* with a nurled head, a graduated dial with 37 divisions, and 18 threads per inch on the body. Passing through this bush, and screwed into the tool slide *a*, is a screw *e*, which also has a nurled head, graduated dial with 50 divisions, and is threaded 20 per inch on the body. Thus one division on the bush dial equals 0.0015 inch and one on the screw dial equals 0.001 inch. For adjustments down to 0.001 inch the bush is locked by the thumb screw *f* and the screw *e* is used. When finer adjustments are required (as when finishing large V threads), they can be obtained in the following manner:

How it Works

Unscrew the bush one division and screw up the screw *e* one division. This amounts to unscrewing 0.0015, and screwing up 0.001, the difference being 0.0005. Of course it must be noticed that the screws have to be adjusted in opposite directions, provided they are both right-hand thread. Hold the outer bushing while the inner screw is adjusted.

I don't see any reason why some method like this has not already been adopted on engine lathes, or even a single screw with a large head and graduated dial would be better than the present method. I hope this point will appeal to some builders of engine lathes. CONRAD.

Cutting Diametral Pitch Worms on the Engine Lathe

The chart herewith will be found a very great help in any shop where the work is such that it requires a little something out of the ordinary. This chart is to be used in a case where fractional worm-thread cutting is necessary for diametral pitch worm threads to mesh into diametral-pitch worm gears.

At the works in which I am employed this often happens, especially so in the manufacture of torpedoes, where the class of work to be done differs entirely from the regular work in a machine shop. Thus, in order that we may overcome this trouble in cutting fractional threads on the lathe, and for the convenience and guidance of the lathe hands, I have arranged this chart in such a manner that it can readily be understood by anyone who desires to use it.

Explanation of Chart

In the first column we find the diametral pitch to be cut. In the second column is found the corresponding single depth of the worm thread. Under the third column is found the width of the tool at the point, the tool being the regular 29-degree included angle. In the fourth column is found the width at the top of the worm thread.

Now in looking at the chart the next thing we come to is the heading "Pitch of lead screw," and here we find the different pitches of lead screws from 2 to 10, excepting 9.

Example: Suppose we wished to cut a worm-thread of 4 diametral pitch on a single-geared lathe having a 6-pitch lead screw. Now, opposite 4 in the first column we find the single depth of worm thread to be 0.540 inch; and continuing in the same direction from left to right, under the next column we find the width of the worm-thread tool at the point or end, which is 0.243 inch, and so on to the next column where we find the width of the worm thread at the top, which is 0.263 inch. Now, we have a 6-pitch lead screw on the lathe. Then all we have to do is follow right on in the same direction until we get to the little square under 6, and the gears will be in the ratio of $\frac{\ }{7}$. Of course there is no 7 gear on the lathe, so we simply bring the fraction $\frac{33}{7}$ to higher denominations, say, $\frac{33}{7} \times \frac{3}{3} = \frac{99}{21}$; that is, put the 99 gear on the spindle or stud, and the 21 gear on the screw. We can then use a gear of any convenient size to act as an intermediate gear, and thus connect the gear on the spindle with the gear on the screw. Suppose we take the fraction $\frac{33}{7}$ and multiply the numerator and denominator by 4; we then would have $\frac{132}{28}$ as the two gears to be used. It will be seen that this last fraction simply changes the number of teeth in the gears, but does not change the value of the fraction; thus we still have the same ratio of the gears.

Let us take another case. Suppose we wanted to cut a 20-diametral pitch worm thread in a lathe having a 4-pitch lead screw. What would be the necessary gears to cut the desired thread? Next to 20 in the first column is found the single depth of the worm thread, which is 0.108 inch. Continuing on, reading from left to right as in the first case, we find 0.048 inch as the width of the tool at the point. In the next column is found the width at the top of the worm thread, which in this case is 0.053 inch. Under

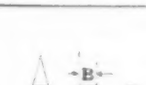


TABLE OF CHANGE GEARS FOR DIAMETRAL PITCH WORMS

E.J. Rantch

Diametral Pitch	Single Depth	Width of Tool Point A	Width of Top of Thread B	Pitch of Lead Screw 2	3	4	5	6	7	8	10
2	1.078"	.487"	.526"	22/7	33/7	44/7	55/7	66/7	77/7	88/7	110/7
2½	.862"	.390"	.421"	88/5	132/35	176/35	44/7	264/35	308/35	352/35	440/35
3	.719"	.325"	.350"	44/21	22/7	88/21	110/21	44/7	22/3	176/21	220/21
3½	.616"	.278"	.300"	88/49	132/49	176/49	220/49	264/49	44/7	352/49	440/49
4	.540"	.243"	.263"	11/7	33/14	22/7	55/14	33/7	11/2	44/7	55/7
5	.431"	.195"	.210"	44/35	66/35	88/35	22/7	132/35	22/5	176/35	44/7
6	.360"	.162"	.175"	22/21	11/7	44/21	55/21	22/7	11/3	88/21	110/21
7	.308"	.139"	.150"	44/49	66/49	88/49	110/49	132/49	22/7	176/49	220/49
8	.270"	.122"	.131"	11/14	33/28	11/7	55/28	33/14	11/4	22/7	55/14
9	.240"	.108"	.117"	44/63	22/21	88/63	110/63	44/21	22/9	176/63	220/63
10	.216"	.097"	.105"	22/35	33/35	44/35	11/7	66/35	11/5	88/35	22/7
11	.196"	.088"	.096"	4/7	6/7	8/7	10/7	12/7	14/7	16/7	20/7
12	.180"	.081"	.088"	11/21	11/14	22/21	55/42	11/7	11/6	44/21	55/21
14	.154"	.069"	.075"	22/49	33/49	44/49	55/49	66/49	11/7	88/49	110/49
16	.135"	.061"	.066"	11/28	33/56	22/28	55/56	33/28	77/56	11/7	55/28
18	.120"	.054"	.058"	22/63	11/21	44/63	55/63	22/21	11/9	88/63	110/63
20	.108"	.048"	.053"	11/35	33/70	22/35	11/14	33/35	77/70	44/35	11/7
24	.090"	.040"	.044"	11/42	33/84	11/21	55/84	33/42	77/84	22/21	55/42
28	.077"	.034"	.038"	11/49	33/98	22/49	55/98	33/49	11/14	44/49	55/49
32	.067"	.030"	.033"	11/56	33/112	11/28	55/112	33/56	77/112	11/14	55/56
40	.054"	.024"	.026"	11/70	33/140	11/35	11/28	33/70	77/140	22/35	11/14
48	.045"	.020"	.022"	11/84	33/168	11/42	55/168	33/84	77/168	11/21	55/84

Formula: $\frac{22 \times \text{Lead Screw}}{7 \times \text{Diametral Pitch}} = \text{Ratio of Wheels}$

Dec. 12-06

CHANGE GEARS FOR CUTTING DIAMETRAL-PITCH WORMS

column 4, and opposite 20 we find the gears necessary for cutting a 20-diametral pitch worm thread in a lathe with a 4-pitch lead screw. The gears thus found, namely, $\frac{32}{48}$ stud / screw may not be in the regular set of gears furnished with the lathe. We may double up on both and make it $\frac{44}{70}$ stud / screw, which is the same in value. The two examples thus worked out could have been cut on lathes with lead screws having any number of threads per inch, with the same result. One point in cutting these threads is in the tool being of exact dimensions all over, for if it is not exactly 29 degrees included angle, or the point is not as it should be for the width, then there will be an error in the worm thread all around. E. J. RANTSCH.

Annealing High-speed Steels

S. I. W. seems to have had his troubles with Novo steel and C. U. Scott, on page 322, doesn't seem to help him much.

Now it doesn't make any difference whether it is Novo or any other brand of high-speed steel, the whole secret of annealing is to get it to a high heat and then let it cool *slowly* without coming in contact with air or getting chilled; and one doesn't need any elaborate apparatus, or to keep it at 800 degrees for 7 hours and then at 900 degrees for 5 hours, either.

Now, let S. I. W. get a big box or barrel of slacked lime and a piece of gas pipe about an inch larger in diameter and two or three inches longer than the piece he wants to anneal. Thread the pipe on both ends, put a cap on one end and put in about an inch and a half of the lime; insert the steel and pack in snugly; fill the other cap with lime and screw it in place. This leaves your steel air-tight and surrounded with a substance which is an exceedingly poor conductor of heat. Now put the gas pipe and contents in the forge fire and heat slowly, turning occasionally to get heat even, and when at a nice white (not burning) heat bury it in the middle of the barrel of lime and leave it 12 or 14 hours. For ordinary-sized pieces the heating will take from 10 to 20 minutes. I generally heat my steel about four o'clock in the afternoon, and it is ready to use the first thing the next morning; and I've never yet, out of hundreds of pieces, had one that I couldn't file, saw, drill or tap with perfect ease, and out of dozens of holes tapped I have yet to spoil my first tap.

HEAT ALONE DOESN'T HARDEN

As to Mr. Scott's idea that high-speed steel gets hard because it is heated to the proper heat regardless of the cooling, let him heat a piece as hot as he likes in the manner I have suggested, just so he doesn't melt the pipe and let it cool in the lime for 12 hours. Then take a piece of it and after making sure it is drillable, let him heat it to a low red and plunge in cold water, and he'll find it too hard to touch with anything short of an emery wheel. He will also doubtless see that high heat isn't the only thing necessary to harden high-speed steel. E. V.

A Diagram for Setting the Tailstock

I have plotted the inclosed diagram for finding the amount of offset of the tailstock to cut tapers expressed in inches per foot. It should save work in the shop where the offsets are usually figured out.

The method of using the diagram is easily seen from an example: If a piece 16 inches long is to be turned with a taper of ⅜ inch per foot, find the intersection of the vertical for a length of 16 inches with the diagonal for the given taper and follow to the left, where the offset will be found to be ¼ inch. WM. CASEY.

[For cases in which the final adjustment must be obtained by trial, the diagram will give the first setting and still save calculation.—Ed.]

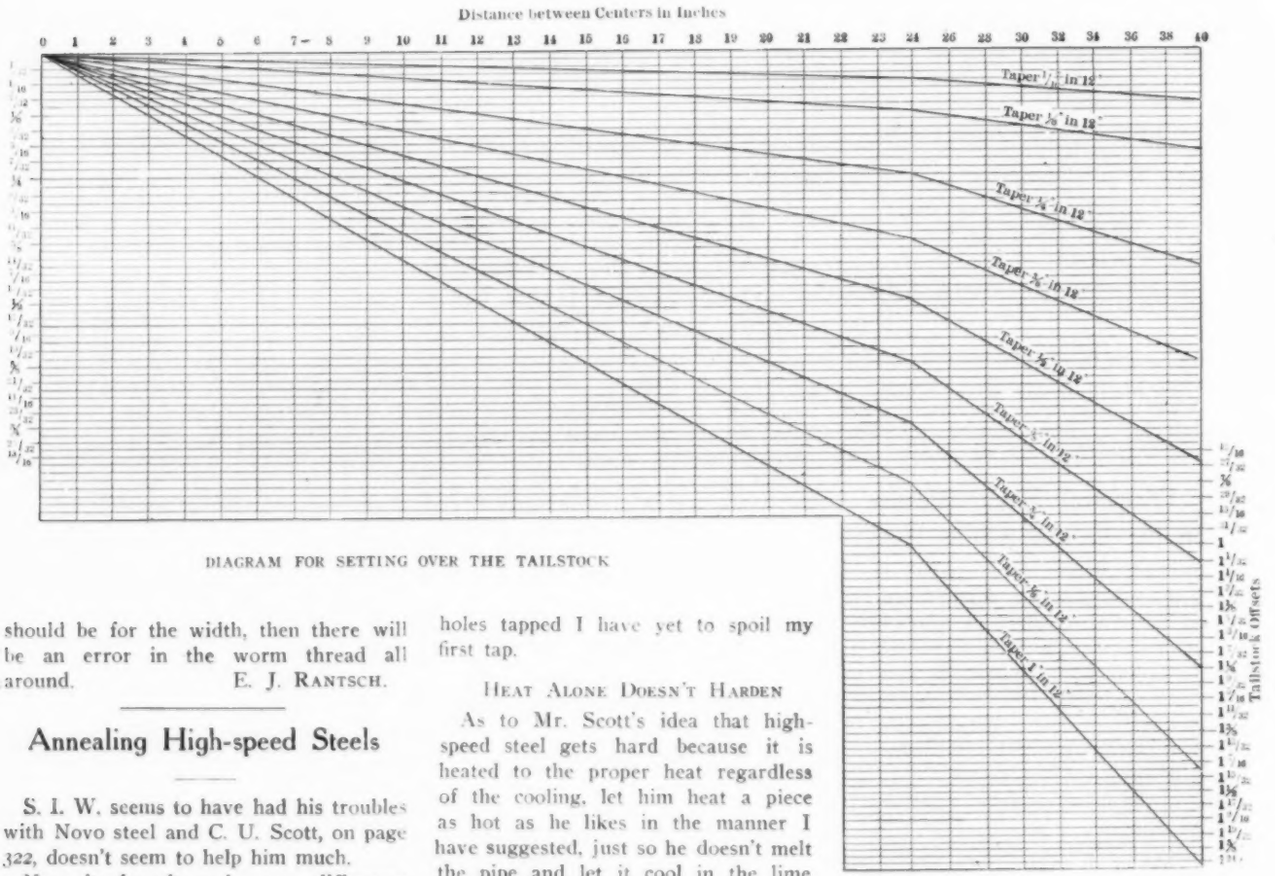

Distance between Centers in Inches
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 26 28 30 32 34 36 38 40
Taper 1/16" in 12"
Taper 1/8" in 12"
Taper 1/4" in 12"
Taper 3/8" in 12"
Taper 1/2" in 12"
Taper 5/8" in 12"
Taper 3/4" in 12"
Taper 7/8" in 12"
Taper 1" in 12"
Tailstock Offsets

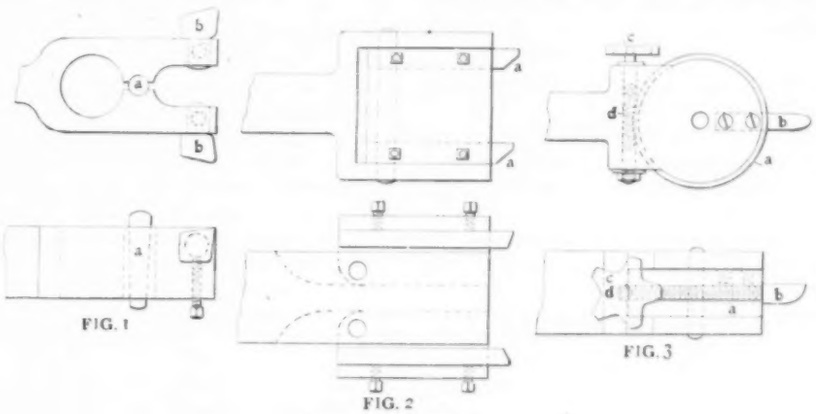
DIAGRAM FOR SETTING OVER THE TAILSTOCK

Box Tools for Small Taper Pins —Nurl Holders

I was very much interested in the taper-turning tool written about by Tapers at page 402. We all have our little troubles in getting the tools to do the work the way we wish it. I don't wish to discourage him from giving us a few more of his tips, but Brown & Sharpe make a tool for the same work, described in their catalog at page 197. I have in my department ten of them in use every day, mostly on taper pins of different sizes and lengths, and one turning taper reamers and broaches for the tool department. On the latter we use two taper-turning tools, one for the finishing cut.

The one he designed has a bushing there, for the work must be done with one cut. The Cleveland automatic has a taper-turning box tool that I have used on larger work to turn tapers ten inches long. I have also used these for fancy-shaped pieces similar to his handles. It is the same as his design, and the work must be done with one cut.

Fig. 2 was designed for light work, and allowed the planer to work upon the return stroke as well as the forward one. The tool holder was made of soft steel case-hardened. The cutters *a a* were held in place by set-screws, and adjusted so that each tool performs an equal amount of work. The tools were set slightly in advance of each other, as the planer fed upon the back stroke, and by setting the feed twice as coarse as for a single-stroke tool, it can be readily seen that what one tool left, the other took. On light work, this tool cut the time in halves. Needless to say, the clapper of the planer must be secured, and not allowed to lift. This was accomplished by placing a jack behind the end of the tool holder.



SOME PLANER TOOLS

On page 386 of the same issue is shown a nurl holder. Brown & Sharpe make one the same style. They call it a top nurl holder. The one shown is an improvement over theirs as there is an adjustable slide that would make it much better for general use. We have more or less trouble with turret nurl holders, to get them with enough adjustment. I wish to say for those who are not aware of the fact that Brown & Sharpe have a very good one they make in several sizes. The largest one for their No. 2 machine has adjustment up to 1 inch and straight-cut nurls are used to cut spiral or diamond shape. The two holders are graduated, and by turning them you get your diamond shape. They have the holders arranged to put a drill or other similar tool in, making it a combination. These tools are not in their catalog, for some reason of their own, but are known as the swivel-turret nurl holder. McK.

Some Planer Tools

Recently, in sorting over a pile of old relics which had been dug from the ruins of the old shop, I came across a bunch of old planer tools, which had not seen active service since the fire. They appealed to me as being available for present use, so I put them into commission again.

Fig. 1 was an adjustable sizing tool for planing connecting-rod straps. The body was made of soft steel the end which held the cutters being bored or drilled out, to allow for spring when the sides were sprung apart by the taper pin *a*. The cutters *b b* were of high-speed steel and held in place by set-screws. Adjustment was obtained by tapping the taper pin in, thus spreading the cutter holder until the required size was obtained.

Fig. 3 was used for planing fillets in large frame castings, where it was desirable that the fillets be uniform. A soft-steel shank forms the body of the tool. This is slotted out ¾ inch wide, to receive the worm wheel *a*. This worm wheel is the actual tool holder, and is rotated by a small worm *d*, which is automatically worked by the star wheel.

TEXAS.

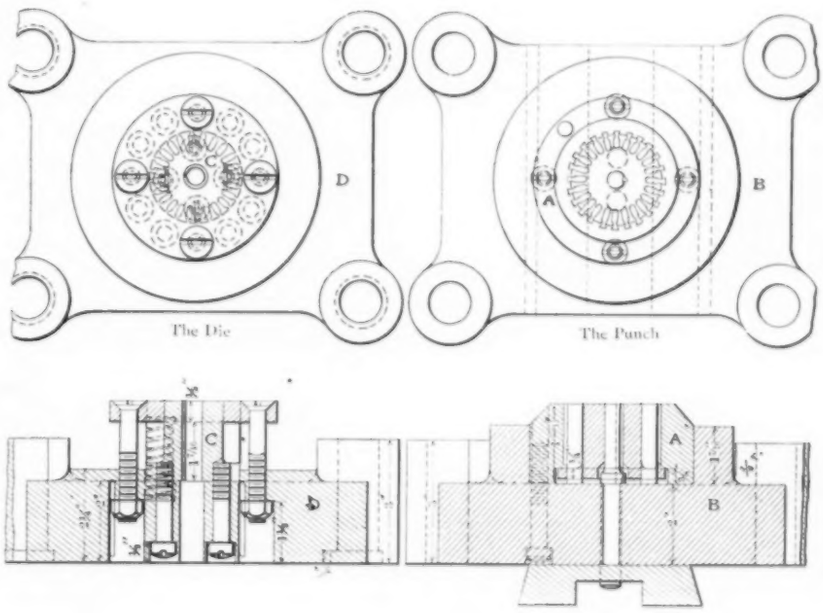
Compound Die for Small Amature Disks

The drawing shows a simple and cheap punch and die for punching a disk used in armature cores for electric motors. The construction can also be adapted for various light iron or, in fact, any metal sheets of different forms. The punch and die are shown in plan and cross section, similar letters applying to similar parts in the different views.

A, the body of the punch, is a ring of tool steel hardened and ground, internally, externally and on the face, which is seated in a cast-iron holder or block *B*. In the ring *A* are inserted, at proper intervals, blocks to form the internal teeth of the punch. These blocks are dovetailed at an angle of 10 degrees, with about ½ degree taper on each side, the slot being larger at the bottom of the ring to prevent the pieces from being pulled out when the die is in operation.

The lower section, or die *C*, is formed from a solid piece of tool steel. After being roughed nearly to size, it is driven on a mandrel which also fits the index head of a milling machine. Holes are drilled in the proper location to form the bottom of the slot, and there is also another row drilled to form the outer semicircle, after which operation the two rows are joined by removing what metal remains between them, by an end mill of proper form.

The die is then hardened and ground to size outside and inside. If no faults



THE PUNCH AND THE DIE

appear through hardening, the die is ready to be marked off on the punch. After laying it carefully on the punch and scribing on the latter the accurate outline of the die, the pieces are driven out. At this point practice differs, some shaping the pieces to size and others milling them. Personally, I prefer the milling process, as, in shaping, the forming tool used is liable to chatter, leaving a poor surface. In either case a fixture of proper size and shape is used to hold the pieces while they are being machined.

The stripping or ejecting device for the punch is made from a solid piece, in a similar manner to the die. There is a flange on the stripper about ¼ inch wide, which enters a counterbored recess in the bottom of the punch, preventing the ejector from dropping out when the punch is in the press. No springs are used with this part, it being actuated by two ½-inch rods which pass through the punch and holder and are struck by a bar fastened to the gate of the press, thereby forcing out the punching from the upper half. On the die, the stripper is simply a circular plate ½ inch thick, with internal projections fitting the die slots. Springs are used under this stripper to remove the scrap.

CO-ORDINATE.

Milling Machine Attachment for Internal Slots

The milling attachment shown in the accompanying drawing was designed to meet the need for an efficient device for milling a ¾x3/16-inch slot 3 inches long,

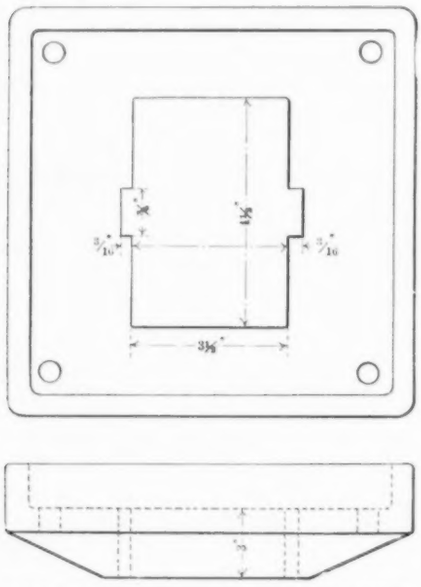


FIG. 1. CASTING IN WHICH SLOT WAS MILLED

in the inside of a hollow casting 3¾x4½ inches inside measurements.

The casting is shown in Fig. 1. The attachment, Fig. 2, fits on the overhanging arm of a milling machine, and the work spindle drives the gear *A*, which in turn drives the gear *B*, mounted on the end mill spindle as shown. The intermediate gear is used for the purpose of securing the necessary length of arm carrying the cutter.

It was first attempted to cut the slot in the casting by means of a special tool in the shaper, but the length of time consumed in the operation made necessary the design given, which reduced the time of cutting to one-fifth that required by the shaper.

C. C. M.

Useful and Useless Mathematics

Dixie gets in his innings on page 256 against technical men. I wonder if he is not just a bit like an insurance agent I once made a deal with. It was a matter of placing a $20,000 or $30,000 fire-insurance policy involving some changes in the property to secure a lower rate. During the talk he remarked that he never would deal with a man under 30 years of age. When we had closed the matter to my entire satisfaction, I asked him how old he took me to be.

"Why, all of 35," he said. I told him that it would be some months before I would be 27. The rest does not need telling.

Now I suspect that Dixie may have quite a few acquaintances among men who are technical graduates, but who have succeeded in so covering up their infirmity that Dixie does not know it. The trouble lies here: that tech men are so known only for a short time after graduating. After a little time they discover that they are merely human, and that the only thing that will save them from poverty is to get out and hustle very much in the same way that their less favored friends do. Then they begin to work up a little, and get the opportunity to use a little of the training for which they paid so well.

I will freely admit that there are shortcomings among tech men; but they are not fundamental ones; they are only superficial and easily worn off by contact with the world. The best thing and the most important thing that a technical college does for a boy is to teach him to think logically from cause to effect. Too many instructors do just what Dixie alleges when he wrote that expression

$$\frac{1 \times 1 \div 1^2}{\sqrt{1}}.$$

But it has its good points as well as its faults. This probably is a formula, general in its use, applied to a special case. The special case which Dixie has in mind was perfectly evident to him—the result was 1. To the student this formula represented the condition in which several matters were taken into account. It was perfectly general in its application, and it would help the man who understood it out of a thousand pitfalls where Dixie might flounder and be lost.

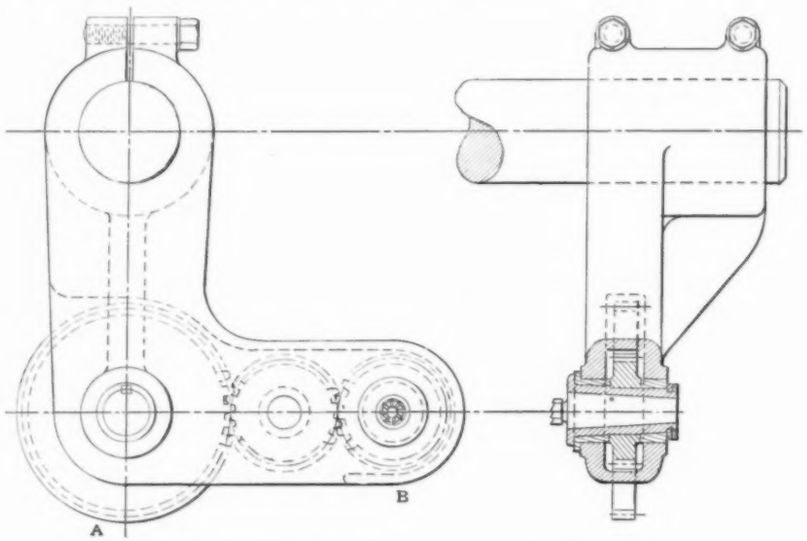


FIG. 2. FIXTURE FOR MILLING SLOT INSIDE A CASTING

I have a friend who is death on technical colleges. He tried to go through one, but something failed to connect; so he withdrew before he had got in deep enough so that he could swim. He found it like a rocky beach, and his feet still hurt him so much that he won't believe there is any good swimming out beyond. And yet I have before me some drawings made under this man's directions giving dimensions down to ten-thousandths of an inch. We thought this must mean business, but when one of the castings would not clean up to size he told us to finish it as large as it would go, and it would be good enough.

Dixie winds up all right. Mathematics must be handled with skill, and with care, too. If Dixie wanted a surface plate scraped especially well would he just show a helper how to use a scraper, and expect him to do a nice job? You just bet he would not. He would get a good man and pay him well for knowing how, and set him at it. And it is just possible that Dixie might not be able to do as nice

a job as this man, but if he couldn't, would he sneer at him? No, because he could see a money value in it. Now if we could show Dixie a money value in some mathematics, wouldn't he be convinced?

Here is the way I got my lesson: My father once ran a contracting business on iron work for buildings, and at the time I refer to the fashion of using structural shapes was just coming in. He rented the top floor of his shop to a firm who did a general contracting business. They were as poor as Job's cats, and so was my father. A few years ago this contracting firm was rated away up in the millions, and my father—well, he was not; that's the difference. It was a rather delicate subject, but one day I asked my father how it happened that the M—— Brothers had got up so far ahead.

"Well, I'll tell you, my boy; they stood in with some architects to have them write their specifications for all wrought-iron beams to carry so much load without bending more than a given amount. All the rest of us had to guess, and in order to be safe we had to guess high; but they hired a technical fellow to figure it all out for them, and they got the jobs with a good margin of profit. When one of us happened to get a contract he knew right away that he had guessed too low, so he had to put in heavier beams and lose on the job."

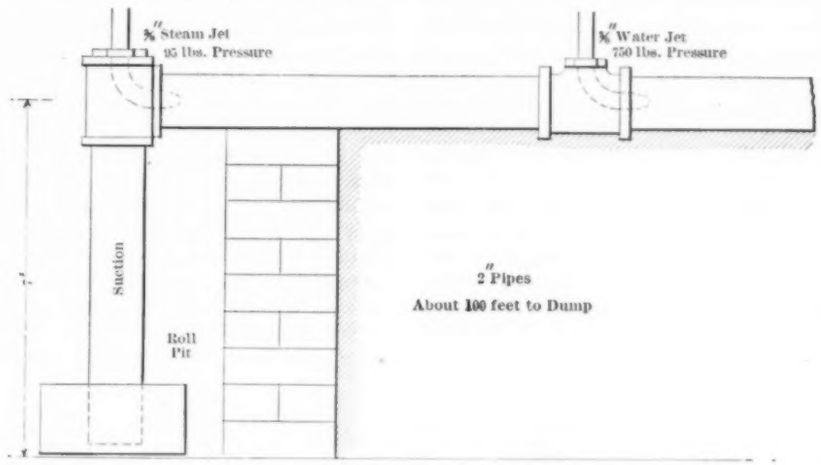
So you see, Dixie, if there had been a little more mathematics hanging on my ancestral tree at the correct time, I should be clipping coupons instead of writing this article. ENTROPY.

Cleaning Scales out of a Roll Pit

Some years ago, while I was in the employ of a large steel company as an erecting and experimental machinist, our general manager gave the chief mechanical engineer an order to devise some way of getting rid of scale nuisance, otherwise than the plebeian way of shovel and wheelbarrow at the rail rolls.

"Blow the scales out by steam," said the manager, swinging his hands in an energetic manner toward the dump, "if you can't do it any other way."

The chief picked on me to do the work. When I asked for sketches or drawings, I was told they had none. I must find my own way to blow out the scales from the roll pit. They told me I could use some old two-inch pipes and fittings handy, and showed me the course to take to get to the dump, about 100 feet or more. On such short notice I did not think of any practical way to make a success of blowing. I told them so, but that if they would permit I would undertake to create a vacuum and draw the scales up and force them out to the dump by steam. "Any way at all," they said, "so you get them out."



CLEANING SCALE OUT OF ROLL PIT

WHAT THE SCALES ARE

I might say here that these scales are particles of steel forming while red-hot blooms are passing between the heavy and various sizes of rolls, which are continually sprayed by streams of cold water to keep the rolls from heating. This causes the outer surface of the blooms, or partly formed rails, to blister and peel off by the sudden chilling effect of the cold water, and these, along with the water, drop into the pit below the rolls, and usually have to be shoveled out and wheeled away in barrows at stated times when the pits become full. So you can understand that there is an abundance of hot water heated by hot scales in the bottom of the pit.

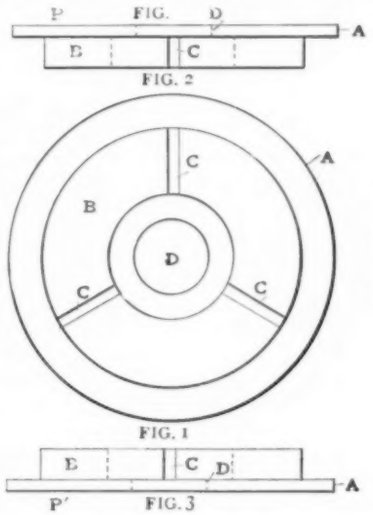
I then made the suction apparatus as shown by the sketch. After getting my pipes and fittings in position I fitted my steam jet as shown. I turned on my steam, and it started at once to "suck," but in a few minutes it stopped and blew out down in the pit. I shut off the steam and started to investigate. I found the first section clogged solidly with scales, pieces of waste wood, and small pieces of scrap iron. I then concluded to put in another jet for high-water pressure at the second T. I then turned my steam on again; it was a success—threw out tons of scales. I afterward changed the system to 4-inch pipes and fittings and ½-inch nozzles. H. M. WOLF.

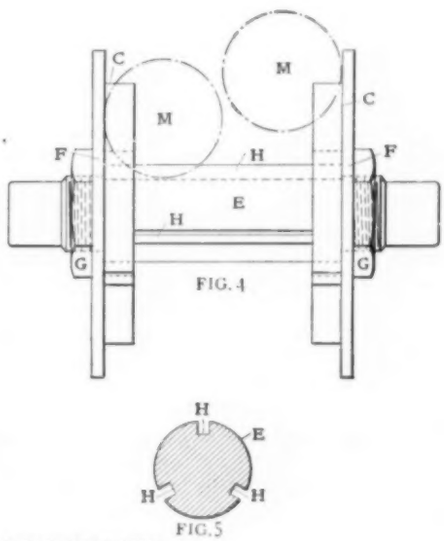
Slotting a Pair of Plates

The accompanying sketches show two details of a special apparatus for making slots opposite each other in a pair of plates.

Figs. 1, 2, and 3 show the details required which were cast-iron plates, right- and left-hand, having flanges *A*, body portions *B* which were slotted in three places *C* and *C'*, and holes *D* at the center.

The slots *C* in the plate *P* were required to be exactly opposite the slots *C'* in the plate *P'*. I made an arbor *E*, Figs. 4 and 5, which fitted the holes *D* in plates





SLOTTING A PAIR OF PLATES

P P', and the latter were placed on the ends of the arbor against the shoulders *F* and clamped by the nuts *G*. The arbor was grooved in three places *H H H*, to a width of a little more than required for the slots *C C'*.

The arbor *E* with the plates clamped on was now set up on the centers of a universal milling machine and a cutter of the proper width first cut the slot *C*, Fig. 4, in the plate *P*; and, without changing the alinement, the work was moved lengthwise so as to bring the plate *P'* into contact with the cutter *M* and then the slot *C'* was cut. It is obvious that the slots are in line as nearly as it is possible for a machine to cut them. The arbor was now indexed around 120 degrees, and two more slots were cut in the same way, and this repeated for the last two.

It was found, on assembling the various parts of the apparatus, that the slots were so nearly opposite to each other that it was almost impossible to detect any error.

C. D. K.

The Automatic-feed Inventive Problem

I herewith present a solution of Mr. Server's interesting little problem which appeared at page 122.

In my drawing I have shown only the business end of the arrangement, as the other part is immaterial, and in Fig. 2 I have omitted the hand wheel for the sake of clearness.

A is the revolving cylinder, *B* the stationary one, *C* the screw and *D* the hand wheel.

Instead of using a revolving screw I have used a stationary one, which is splined full length and screwed into *B*, or keyed; also a revolving nut *E*, on which the hand wheel *D* is mounted. *G* is a gear wheel and sleeve provided with a key so that it can slide along the screw *C* but not revolve. *H* is a gear wheel equal in pitch diameter to *G* and it clutches with gear *J* which drives *K*. The ratio between *J* and *K* is 6:5. For every revolution of *A*, *H* rolls around *G* and makes one revolution (in the same direction) because they are equal in size; *J* also makes one revolution. For every revolution of *J*, *K* will make 1 1/5 revolutions in the opposite direction; therefore when *A* has made one turn forward, *K* will have made one-fifth of a turn backward, and as it clutches with the nut *E* this will revolve with it and give the necessary feed.

The Arrangement for Using Automatic or Hand Traverse, as Desired

L is a ring pressed against *K* by two or three spring plungers *M*. *F* is a flange fastened to the hub of the hand wheel *D* by screws, as shown. The round-headed pins marked *R* are driven into the hub of the hand wheel *D* and their heads fit into hollows in the flange on *E*, as shown. The screws *S* (Fig. 2) are screwed tight into the hub of *D*, leaving just a little more space between the bottom of their heads and the flange on *E* than the thickness of the heads on the pins *R*, and they work in the slots in the flange of the nut *E* (Fig. 2). *Q* is a cover machined where flange *F* comes in contact with it.

To start the feed the hand wheel is turned to the left about one-half revolution. This causes the screws *S* to turn the nut *E* and advance it along the screw *C* until the flange *F* clears the cover *Q* sufficiently to allow the ring *L* to push the gear wheel *K* into engagement with the nut *E*, the heads of the pins *R* dropping into the hollows in *E*.

To disengage the feed seize the hand wheel, thus causing the screws *S* to move to the opposite ends of their slots, and the heads of the pins *R* to move out of the hollows in the flange of *E*, causing a small longitudinal movement of the hand wheel *D*, which pushes *K* out of engagement with *E*. If the hand wheel is then turned to the right the nut *E* will travel along the screw *C*, pulling the cylinder *A* along with it by means of the screws *S*, flange *F*, and cover *Q*.

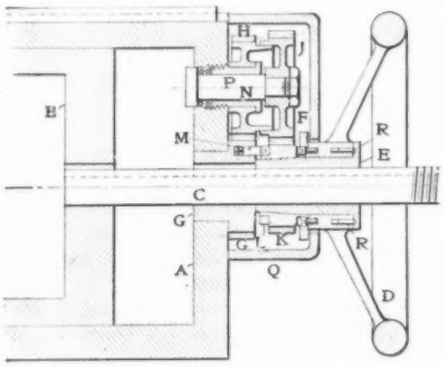


FIG. 1. LONGITUDINAL SECTION

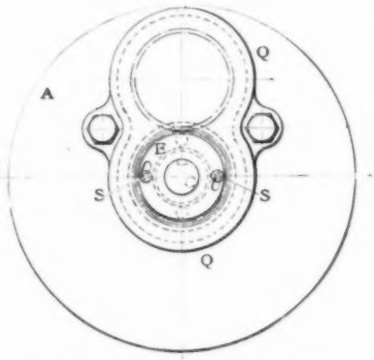


FIG. 2. END ELEVATION, HAND-WHEEL *D* NOT SHOWN

The Automatic Safety Knock-out

The clutch between *H* and *J* is a safety arrangement to prevent the end of cylinder *A* running up against *B*. *H* is mounted and runs freely on a sleeve *N* screwed into *A*. *J* is fixed on the spindle *P* which runs freely in the sleeve *N*, and has a head on its inside end, and between which and the end of *N* is a compression spring which causes *J* to clutch with *H* until the cylinder *B* comes in contact with the spindle *P* and pushes it enough to declutch them. If this safety arrangement were not necessary, the gear wheels *H* and *J* could be fixed together and revolve on a plain stud.

If it was found necessary, a ball race could be provided between the flange *F* and the gear wheel *K*.

How a Reverse Might Be Arranged

Although a reverse motion is not called for in the problem it would be a very simple matter to fit one to this design. All that would be required would be to make a boss near the root of one of the spokes on the hand wheel. Through this boss would pass a small shaft having on its outer end a short trigger lever and on the inner end a small steel catch radiating in the same direction as the trigger and adapted to catch a steel block fixed on the cover *Q*.

In the off position, the trigger would be held by a spring, tangential to a circle, concentric with the rim of *D*. To make the catch engage, the trigger would be turned to a radial position, when the end of it would stand close to the rim of *D*, and the catch would be in the path of the block on *Q*. To disengage, the workman would touch the trigger with his finger as it came around and knock it to its off position.

HAROLD SMITH.

England.

[O. B. Server, in his statement of the problem described the screw *C* as working in and out of the cylinder *B*, whereas Mr. Smith has used a stationary screw; we are, however, presenting his design, which shows considerable ingenuity.—ED.]

Turning the Ends of Square Rods on the Drill Press

The sketch shows the job, the tool by which it was produced and the gage plug, which rendered the setting of the tools in the tool box a very simple matter. Fig. 1 is the job, Fig. 2 the tool and Fig. 3 the gage plug.

It was necessary to turn one cylindrical end on a long, 1-inch square bar from rough stock, the quality of the work being of secondary importance. The length of the bar and the shape of the end not shown were such that to attempt to handle it in the turret lathe was an awkward proposition, aside from the fact that the output from a tool of this class would not begin to approach the requirements. A suggestion by the master mechanic was to place the job on the drill press, where, if the proper tools were devised, one man

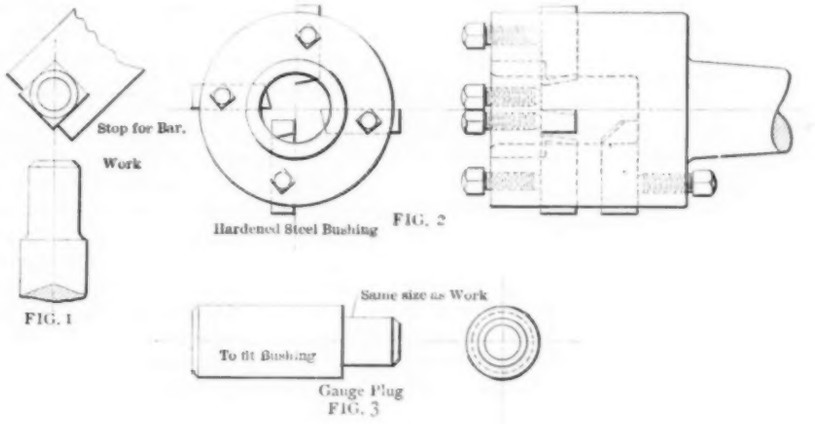
could operate a gang of machines, thereby not only increasing production, but materially decreasing the labor expense.

In response to this suggestion the tool, Fig. 2, was designed, the chief feature of which is the bushing in advance of the tools. It often happens that the time occupied in fixing and clamping pieces to be machined is greater than that required for the actual machining, and therefore any device which eliminates this clamping is an important factor in results. Such a device is the tool-steel locating and steadying bushing in Fig. 2, which, while extremely simple in construction, is the most important feature of the entire outfit.

For locating the lower end, a piece of rough flat stock, having a conical depression of such a size as to contain the end of the bar, is clamped to the base of the drill press directly under the center of the spindle. A second piece is so placed that the bar, after having its lower end located, may be brought to a vertical position by placing it within a slot cut therein, which supports the bar on three sides, as indicated in Fig. 1. It is only necessary, then, to bring down the spindle until the cutters in the tool box come into action, when the feed gear is thrown in. The operation is finished by running back the spindle in the usual way, until the bar is free to be removed.

The gage plug is used when the tools are removed for grinding, etc. Insert the plug in the bushing and adjust the tools until they come into contact with the end turned to the size required on the work.

JOHN PRICE.



TURNING THE ENDS OF SQUARE RODS IN A DRILL PRESS

Shrinking a Link Hanger to Suit a Small Bushing

The place was the machine shop of a large sawmill in the South, and they were working three or four machinists overhauling locomotives besides the work from the mill, and were having a hard time to keep suitable men, as the shop was situated 40 miles from a town of any size, and the labor market is not what it is in the North.

One man who had been in the shop but a short time had been working 5 or 6 hours on a bushing for a link hanger. He had just taken it out of the lathe, when the master mechanic, passing along, carelessly picked it up and tried it in the hanger, and it slipped in easily when it should have been a press fit. He asked the machinist how that was, and he said, "Well, I got that a little small." The M. M. mentally noted the time that had been spent on it and said, "We cannot stand for that kind of work; here is an order for your time."

The next day the M. M. took the link hanger to the blacksmith shop, brought it back and to the wonderment of the vise hand told him to press the bushing in, which he did and it was a nice press fit. This was what was done to it:

Some fire clay mixed good and stiff, not too wet, was packed into the hole hard, then heated to a good red heat and immersed in cold water, and cooled as quickly as possible. That was over a year ago and that bushing is tight yet.

Of course this will not work on cast iron, but on wrought iron and soft steel it will reduce the size from 0.025 to 0.050 inch according to the amount of stock around the hole.

C. H. EVERETT.

Arithmetical Short-cuts—Squaring Numbers

Quite a lot of information has appeared in recent numbers on the above subject, and Professor Sweet, at page 284, makes a very useful enlargement upon this information.

However, most of the matter appearing has related to numbers ending in the figure 5. Even Professor Sweet's fractional numbers when decimally expressed end in the same figure: $\frac{1}{2} = 0.5$, $\frac{3}{4} = 0.25$, $\frac{1}{8} = 0.125$.

Perhaps a description of the method used by the writer in squaring other numbers, i.e., numbers ending in figures other than 5, will not be out of place.

Everyone, perhaps, is familiar with what may be termed the Euclid II, 4-method of squaring numbers, expressed algebraically by $(a+b)^2 = a^2 + 2ab + b^2$ but this, I think, involves greater mental effort than the following:

Take 37 as an example. Mentally I proceed thus: Seven 7's are 49; 9 down and carry 4; six 7's are 42, and 4 (carried over) are 46; 6 down and carry 4; three 3's are 9 and 4 (carried over) are 13. Total, 1369.

Graphically this will appear:

```
                37
                37
                --
7 × 7 =         49
6 × 7 =         42
3 × 3 =          9
                --
              1369
```

The 6 printed in heavy type is *twice* the "tens" figure in the number.

A further example, 69^2:

```
                69
                69
                --
9 × 9 =         81
12 × 9 =       108
6 × 6 =         36
                --
              4761
```

The 12 printed in heavy type is *twice* the "tens" figure in the number.

Although for convenience the above working appears in three lines, when mentally done one line, and that the result only appears.

Careful examination shows this to be an inversion of the formula

$$a^2 + 2ab + b^2, \text{ or } b^2 + 2ab + a^2.$$

Higher numbers, of course, are more cumbersome to deal with mentally, but the above method is available for even these with the aid of paper and pencil. A number such as 709 is fairly simple, thus:

```
                709
                709
                ---
9 × 9 =          81
140 × 9 =      1260
70 × 70 =      4900
                ---
              502681
```

FRANCIS W. SHAW.

Preparing Tracing Cloth—A Blueprint Trick

Many draftsmen use the dull side of the tracing cloth or prepare the smooth side by rubbing with chalk dust. A much better way is to use the smooth side and wash it thoroughly with alcohol by means of a piece of soft cloth or cotton waste. The alcohol does not soften the tracing cloth at all. It does not even destroy the gloss, but cuts it enough to make it take

the ink perfectly. The advantages over the chalk method are: First, cleanliness, no dust left to clog the pen; second, it takes out the curl, so that when the tracing is removed from the board it will lie perfectly flat; third, it shrinks the cloth slightly, so that after drying, which takes but a few seconds, it will be stretched tight and smooth over the drawing.

I once wanted a copy of a drawing that was on thick bristol board. I placed it in the frame face up, that is, so that the back of the paper would be toward the light when printing. I then placed a piece of thin, quick-printing paper in the frame, also face up, or back toward the light. The print came out right side to and perfectly clear, there being only the thickness of the blue-print paper between the ink and the sensitive side.

J. R. Eldred.

Engineering Handbooks—Technical Information in Shops

I was much interested in Mr. Plaisted's reply, at page 223, to my letter on the proper way to use a pocket-book. I infer from what Mr. Plaisted says that he feels himself aggrieved at having to buy so much information of which he thinks he can make no use, when he buys the average pocket-book. Now I will agree that no single person, or at any rate, not one out of twenty, will ever have any use for a half of the information contained in the pocket-books he buys, even if all of it is in such shape that he can understand and apply it. There are hundreds of pages in those reference books which I use most frequently, at which I never look, and for which, as far as I know at present, I have no use. That does not make the books less valuable, however, but more so. Some day I shall want that information badly. I shall want it in a great hurry, and I shall know right where to get it.

Mr. Plaisted may rise to a point of order here, and say that he is not objecting primarily to too much for his money, but to the fact that these books contain information on subjects which he desires to understand, in a form that is unavailable to him. I will admit that this is exasperating, but the fact is that if one of the Minor Master Minds were to prepare a pocket-book with special reference to Mr. Plaisted's needs and abilities, leaving out everything that was not patently useful to him, the book would justly have a very small sale.

The fact that I use a vocabulary limited to six or eight thousand words is no reason why I should not be the possessor of an Unabridged Dictionary, and find it exceedingly useful. In the same way, an engineering pocket-book is prepared for the use of a hundred thousand men, of varying needs, and all degrees of ability, and it contains the information most useful to the whole number in the simplest way in which it is possible to present it. No one can draw a line, and say that this information will be valuable to machinists having a grammar-school education, and may be understood by them, and this other, while it may be valuable, cannot be understood. As regards the material which is presented, I cannot see that our present pocket-books are open to any improvement.

A Little Knowledge is a Dangerous Thing

As regards the way in which this material is presented, it is generally well done. Of course it would be easy to point out a dozen, or possibly a hundred places, where any particular book could be greatly improved by changing a few words or sentences, or by a different treatment of some particular thing. That is not, however, an objection to the books in any sense. It is merely a chance for improvement which the authors and publishers would like to have brought to their attention, in order that the book may become more valuable with each succeeding edition. There is an objection to presenting such things too simply, and in making them available to those having an imperfect understanding of the principles involved, and that is this: We may encourage a designer to attempt a construction, a boiler, or a bridge, or a crane girder, or something of the kind, which will be perfectly satisfactory in most points, but which will be fatally weak in one. It is desirable that the presentation of a subject be made sufficiently difficult so that a man will not think he understands it until he really does.

Let us take as an example of such a case, a riveted boiler joint. I do not doubt that most designers would prefer a pocket-book giving a table of rivet diameters, pitches and laps for different thicknesses of plates, instead of the mass of information given in Kent. They want their information in definite form even when it is about a subject that is by its very nature indefinite. Were such a table given and used, it might be very satisfactory nine times out of ten, but the tenth time, because of a change in the material, the dimensions might be wasteful on the one hand, or dangerously scant on the other. The right way is to master your subject, even if it is at the expense of a little time and gray matter.

Sacrificing Accuracy for Simplicity

The remark that Mr. Plaisted makes about the strength of brass is another illustration of the fact that the average man prefers definite information which is wrong to information which is right, but which appears to him to be indefinite. It may be very comforting to turn from a wearisome column of compositions and strengths to the succinct statement that the strength of brass is 18,000 pounds per square inch, but the fact remains that the strength of brass is not 18,000 pounds per square inch, but that it varies from 28,000 to 48,000 pounds, with average sound castings running not lower than 35,000 pounds per square inch. If Mr. Plaisted does not know the composition of the brass, he might ask the foreman of the brass foundry, who could doubtless give him some information from the appearance of the fracture.

Avoiding Obscurity in the Use of Symbols

Before we leave the question of pocket-books, I wish to state that in my opinion an attempt to establish a standard system of symbols for engineering formulas is impracticable. In fact I doubt very much whether it is desirable, granted the practicability. I have a counter proposal to make, which will in my opinion do away with the difficulties of the present system, or lack of system, without being in any way impracticable. It is this: That whenever a formula is to be derived, the notation should first be given, defining the symbols to be employed, unless those symbols have all been defined on the same page, or the opposite page, of the publication. When a formula has been given without derivation, the symbols employed should be defined immediately after, unless all of the symbols have already been defined on the same, or on the opposite page. In case the derivation of a formula extends over a page, the symbols should be defined as if the formula had not been derived. The practice of giving page after page of symbolic equations without a definition of the symbols is a glaring fault in many otherwise excellent text-books. As an example of how the practice I advocate would work, let us take a formula for the thickness of the shell of a boiler. The thickness of the shell of a boiler should be found by the following formula:

$$t = \frac{p D}{2 E f};$$

where t is the thickness of the shell in inches,

D is the diameter of the inside of the shell in inches,

p is the working steam pressure in pounds per square inch,

E is the strength of the riveted joint, expressed as a decimal of the strength of the solid plate,

f is the safe working stress of the material of the shell in pounds per square inch.

Were the whole number of quantities which the engineer has to use, and for which he needs symbols, less than fifty-two, we could get along very well with a standard system of notation, but since the number of symbols required would run into the hundreds or thousands, it is impracticable to arrange any standard notation.

GETTING INFORMATION ON TROUBLESOME PROBLEMS

But to return to Mr. Plaisted's communication. The most important suggestion which it contains is that of the desirability of a bureau of information in general, which will for a consideration undertake the engineering problems of a troublesome nature, and solve them. The suggestion is an excellent one, in some ways, and has been carried out to a considerable extent, although not in the exact way that Mr. Plaisted indicates. There are a great many consulting chemists who will analyze steel, iron, alloys, coal, water, or any other substance in which the engineer is interested, and their charges are very reasonable. Firms supplying specialties are always willing to give all the information possible about their products. Any number of reputable consulting engineers will undertake design problems beyond the powers of the ordinary individual, and considering the excellence of their work, the fees will be extremely reasonable. The publishers of our mechanical papers are always willing to send you, without any delay, any information that they have at their command, if you will only inclose a stamped and self-addressed envelope. If they cannot answer your questions themselves, they will tell you the names and addresses of the people who can. And they will feel that they are being favored by your questions, instead of bothered, provided only that your letter is reasonably explicit, and politely worded, the penmanship is readable, and you do not forget the stamp, and self-addressed envelope. I know, for I once worked for a mechanical paper myself.

A SUGGESTION—HOW TO PROVIDE FOR FIGURING JOBS WHICH ARE BEYOND THE ORDINARY MECHANIC

But would it not be just as well for Mr. Plaisted to employ a technical graduate, with sense and ability enough to handle the problems which come up day by day that are beyond the ken of the ordinary mechanic, bear with him a few months till he is able to earn his salt as a mechanic, or a draftsman, or an errand boy, or any sort of a job which it may be expedient to give him, and pay him two or three hundred dollars a year to act as a consulting expert, in addition to the money he may earn as a regular workman? If he has the right sort of stuff in him, he will earn the money several times over, if given the chance. If he makes good, promote him, and give him enough pay so that he will not always be hunting the "Wanted" column for a better place. If a shop doing $5,000,000 worth of business a year can afford to have an engineering staff of technical graduates, a shop doing $50,000 worth of business a year cannot afford to be without a technical graduate, if it is to remain in the field. Might it not be well, Mr. Plaisted, to have your information bureau as a permanent part of your own establishment?

On second thought I do not know that that technical graduate is entirely necessary. As I look back over my college course, I do not recollect that I learned so very much there that I could not have learned outside. I am inclined to believe that if the right sort of a young man, or old man either, were to get right down to business five nights a week, and apply himself to the mastery of the profession of mechanical engineering, that he would in the course of a few years become a pretty good one. There is nothing in the ordinary pocketbook which he could not master in the course of two or three years, and the only point where he would be at a disadvantage as compared with a technical graduate would be in his lack of laboratory experience. I know one or two men who have done that very thing, and they are recognized as first-class engineers. If Mr. Plaisted, or one of the boys in his shop wishes to make the effort, he may become an engineer in the way that I have indicated.

I do not anticipate, however, that many will make the attempt. Most of us have not the grit nor the gumption to carry the thing through to a successful finish. It is too much like hard work. It is a good deal easier to get your education in college, or to go without. So while that technical graduate is not strictly necessary, he is advisable, and if you will give him a chance, he will be very useful.

FORREST E. CARDULLO.

Trolley Rollers and Gearing Ratios

Your correspondent who shows "a simple crane trolley" at page 290, has evidently missed the last few issues of the AMERICAN MACHINIST, or he would have been convinced that the conical roller is not correct for this kind of runway. The bearings should also, I think, be in the rollers and not in the plates. As shown, a light load would be sufficient to lock the bearing studs in the holes.

At page 294 a new plain milling machine is illustrated, and in the description it is stated that "the feed belt runs at a very high speed, the gearing ration being 361 to 1, giving a very powerful feed." This method of stating the gearing ratio is common, yet misleading. For instance, if the machine in question had a screw feed to the table instead of a rack, the gearing ratio would have been stated as much less than 361 to 1, and yet the power would have been the same, though more of the power might be lost in friction in one feed drive than in the other.

A more correct way would be to state the mean area of belt contact per unit of (in this case) table travel and then regard the different methods of drive as more or less efficient. This may not be a very important point, but it shows how we follow old ways, especially in the descriptions of machine tools. B.

Quick Way to Make an Extension Drill without Solder, Screw or Cross-pin

Take a piece of round rod, preferably brass; chuck it in the lathe; center it, using a diamond hand tool; take a drill a size smaller than the drill you intend to use and drill a hole of suitable depth, according to the number of drill you want to use. Then take the rod out of the chuck, clamp the drill between brass jaws in the vise, and drive it home till it strikes the bottom; and there you are. This way of making an extension drill never failed to serve its purpose; if, however, it should fail, then the trouble is that your smaller size drill was not sharpened true, and therefore made as large a hole or even larger than the drill you wanted extended; consequently it never could hold. LOUIS CERVENY.

A Makeshift Drive Fit

The other day one of our men was at work on a pin for a sawmill and, as the directors of the mill had just arrived from the North and were anxious to have the same in operation, of course our man made the body of the pin that should have been a good drive fit just *too loose!*

At first, we could see no way out of the difficulty but to make a new pin, but as this would take almost a half a day and as the mill men wanted to get started worse than "bad," we had the pin heated and treated it to a coat of brass just as if we were to braze it.

After filing up with an old file, the desired drive fit was found to be about all that could be desired, and this makeshift took but a short time.

REPAIR SHOP.

At the University of Illinois, Urbana, Ill., there are now offered under the direction of a school of railway engineering and administration, courses in railway civil engineering, railway electrical engineering, railway mechanical engineering, and railway administration; in these courses more time is given to the study of economics than is usually given in engineering courses; the last one named contains enough work in engineering to give the students of administration an understanding of the technical problems arising in the engineering departments. It is hoped by the university authorities that these courses will offer an adequate preparation for those who expect to occupy responsible positions in the respective departments.

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Employment Bureaus in the Engineering Field

There are reputable agencies in the engineering field that are of some use and benefit to men in our line of business, both employer and employee.

Rightly conducted we have no objection to them; but we have serious doubts as to their usefulness, because they are conducted on what we consider bad business lines. The general plan is to charge the applicant for employment an "entrance fee" or a "registration fee." This plan makes the human nature of the agency strive to get as many men to pay the registration fee as possible, regardless, more or less, of their ability.

Once registered the average applicant is coaxed along from one hope to another, and from one fee to another. There are more men on the register than can get the jobs available, and some of these men pay their money for less than nothing and blame the AMERICAN MACHINIST more or less for allowing such advertising to appear.

This plan partakes something of the lottery—many must draw blanks that a few may win.

We will not accept any more advertising from firms that charge a fee, under any pretext, for putting men on the list. Neither will we accept advertising from any firms who charge men securing positions a percentage on their salary for any given time.

This service is largely for the benefit of the employer, and he should pay for it.

When he does pay for it he will demand from his agency good work in the investigation of the record and ability of all applicants, and not be content to try out a lot of doubtful men because the agency will send him all he wants for nothing.

Then the applicant for work will have to show that he can "make good" to the man that hires him—not that he can pay a fee or a commission to the agency.

In the end the employer pays the freight anyway; let him pay it first hand and demand the service he is entitled to.

In answer to an ever increasing inquiry as to the reliability of this or that agency we want to say here and now that we believe all those advertising are conducted by honest men, but that we advise our readers to decline to give up money to be "registered"—there are too many blanks to draw. Decline to pay part of your wages for a job. Advertise yourself, honestly and fairly, and you can get a job cheaper and better than through an agency.

To employers in our line we would say, when an agency comes along that has the machinery for finding the men you want and proposes to serve you—and charge you for it—don't think they are robbers; it pays to deal first hand.

Some time an agency will be started that does something *for* the employer and nothing *to* the employee. That will be the one both should patronize. In the meantime we shall accept no more advertising from any agency run on the old-fashioned lines. We propose to accept no advertising of any kind that we cannot advise our readers to answer and spend money on.

Diagrams versus Formulas

The extracts from Mr. Taylor's paper on The Art of Cutting Metals, which we publish elsewhere this week, suggests some remarks on the use of formulas and diagrams in connection with work of this kind.

The appreciation of the diagram as a method of presenting technical information has been steadily growing for a good many years, and the fact that Mr. Taylor's paper presents both formulas and diagrams side by side offers an excellent opportunity for comparing the merits of the two.

Will the reader glance at the formula given in the upper left-hand corner of Mr. Taylor's Fig. 2, and, if he feels like pushing the comparison to the limit, will he please get out his table of logarithms and work out a case by the aid of the formula, and then see how many such cases he can work out in the same length of time by the use of the diagram? After he has made his comparison, will he please answer, or try to answer, the question: Of what use is the formula?

We are quite satisfied that the efforts to fit formulas to the results of experiments have been pushed far beyond the point of usefulness.

There are two ways in which engineering investigations are conducted. An example of the first way is found in connection with the strength of beams. In this case, mathematical analysis results in a rational formula, the only thing lacking when the analysis is finished being certain constants that must be obtained by experimental investigations. When found, their substitution makes the formula complete. The other class of investigation is illustrated by Mr. Taylor's work, in which there is and can be no preliminary mathematical analysis. No one would, we think, attempt to obtain by this process an equation which, even in its general form, should represent the law which it is desired to discover. This law is purely empirical, and the procedure here is first to make the experiments, then to plot them on a diagram, and finally to obtain an equation which shall, as nearly as possible, fit the resulting curve. The equation is thus at the end of the process instead of the beginning, as in the former case. In the former case, it is a means to an end, while in the latter it becomes the end.

As an end, what is it good for? At best

it is but an approximation to the results of the experiments, the diagram being more accurate than the equation. The diagram can be used in a fraction of the time that the equation can be, while a collection of equations can no more be carried in one's mind than can as many diagrams. The diagram presents to the eye a graphie picture of the manner in which the variables are related, while the equation, as a rule, gives no such picture. One uses the diagram with his eyes open, so to speak, whereas the use of the equation is substantially a case of blind staggering after results. The only advantage which the equation offers is that it can be more readily written down in a notebook than the diagram can be traced; but, given the two side by side, we doubt if a man can be found who would use the equation in preference to the diagram. It seems to us that when the experiments are plotted and the resulting curve drawn, the useful work is finished, and that the fitting of a formula to the curve is pretty nearly wasted effort.

Our columns bear repeated witness that many have constructed diagrams from equations because they are so much more readily used, but if anyone, except for academic reasons, has gone through the reverse process, we have yet to hear of him. If the diagram is the ultimate thing, what is the use of working out an equation when the diagram is already at hand? It is one thing to derive an equation from an analysis of a subject and then use it because a diagram has not been made, or as a means of making a diagram; but it is another thing to work out an equation from a diagram which has resulted directly from observations and tests. If a diagram is to be the final result, the equation is a necessary step toward its production in the first case; but in the second we are unable to see that the equation accomplishes any good purpose whatever.

These views are, of course, rank heresy, but we should be glad if some of our mathematical readers would point out wherein they are other than good sense.

A Museum of Security

The exposition of safety devices and industrial hygiene held last winter by the American Institute of Social Service, in New York, is to be made a permanent museum of security.

At the meeting of the executive committee of the institute held last week at the Players' Club, as the guests of Richard Watson Gilder, announcement was made that the *Scientific American*, through a desire to co-operate with the work of the institute in promoting an American museum of safety devices, would give annually a gold medal to be awarded by the institute for the best device for preventing accidents.

An advisory committee of the editors of the leading technical papers was organized to co-operate with the institute in the work of protecting life and limb. As at present constituted the advisory committee consists of fourteen representatives from the AMERICAN MACHINIST, *Scientific American, Iron Age, Railway and Locomotive Engineering, Automobile, Electrical World, Street Railway Journal, Dry Goods Economist, Electrical Age, Railway Gazette* and *Engineering and Mining Journal.*

Dedication of the Carnegie Engineering Building

The program for the dedicatory exercises of the Carnegie Engineering Building has been announced. The exercises will begin Tuesday afternoon, April 16, and will include the presentation of the gavel by Mrs. Carnegie, the acceptance of the building by E. E. Olcott, president of the United Engineering Society, in which is vested the title to the property, and an address by Mr. Carnegie. In the evening there will be a reception in the main auditorium and in the rooms of the various societies. Wednesday afternoon there will be a series of addresses by the presidents of the various societies, the presentation to the Society of Mechanical Engineers of a portrait of George H. Corliss, and the presentation of the John Fritz medal. Thursday afternoon there will be a session of the Institute of Mining Engineers, Thursday evening a session of the Society of Mechanical Engineers, and Friday afternoon a session of the Institute of Mining Engineers will be held. Friday evening there will be an informal smoker and vaudeville in Madison Square Garden.

A Machinery and Metal Trades Club

The movement for the formation of a downtown machinery and metal trades club, in connection with the proposed reconcentration of machinery interests in a common center, was formally inaugurated at an enthusiastic meeting held at the rooms of the Board of Trade and Transportation the afternoon of April 4. The meeting was called to order by Francis H. Stillman, who has been the originator and leading spirit of the entire movement. The proposed location of the new club is in the Fulton building, which the Hudson & Manhattan Railroad Company is now building, and which, with its companion, the Cortlandt building, is to be the downtown terminal of the tunnels which that company is now building under the Hudson river. Mr. Stillman stated that 325 names were already enrolled as in favor of the movement, and this fact together with the enthusiastic temper of the meeting leaves practically no doubt of its success. An organization committee of 28 was elected, with Mr. Stillman as chairman, which will proceed with the formal organization and incorporation of the club. The new building, of which the foundations are now about completed, is expected to be ready for occupancy the first of May of next year. The original plans contemplated the reservation of two entire floors of the building for the uses of the club, but present indications are that three floors will be needed and, should that prove to be the case, they will be available.

There can be no doubt that Mr. Stillman has done a genuine service to the machinery interests, not only of this city, but of the entire country, by his far-sighted enterprise in inaugurating a movement which now bids fair to be triumphantly successful.

Are Special Export Catalogs Necessary?

The question as to whether it is essential for success in export trade to have catalogs published in various foreign languages is one upon which an enormous difference of opinion and practice exists. There is also the question as to whether or not it pays to distribute circulars in foreign languages. For instance, take the case of a maker of steam engines, having dealings with the European markets, Japan, South Australia and South America. If we except the strictly speaking English countries, and also Japan, where the English language is spoken to so large an extent that it is unnecessary to consider any other language, there are still the European and Spanish-speaking countries to reach. The translation into any of these languages of a bulky catalog is a serious matter, owing to the necessary use of technical terms and expressions which have absolutely no equivalent in some of those languages. Not only is the translation work a slow and expensive process, but the expense of printing is large and the expense of distribution and correspondence entailed is also large. Under such conditions it will readily be seen that to undertake such a task means a great deal of work, time and money, without perhaps being fairly certain that the results will be commensurate with the expenditure.

We are repeatedly being told by consuls of all nationalities that catalogs must be in the language of the country to which they are addressed, and that such a policy is imperative if one would be successful in foreign business. These officials also state that all other countries pursue this course, and that a prosperous export trade can only be built up on such a system. It would be very interesting to know whether it really is a fact that foreigners

do pursue such a policy in all lines, or whether as a matter of fact it may be said that this policy is pursued in the sale of what may be termed "staple commodities" or goods that can be sold from samples or from catalogs. There is also another question to be considered before anyone incurs the heavy expenditure entailed in the production of such a catalog. It relates to the spread of the English language in foreign countries, especially as affecting trade relations. In the Spanish-American countries the use of English is steadily extending in a good many branches of industry, so that in one sense it might be best not to extend the "export" catalog idea in that direction.

It is impossible to lay down a hard and fast rule in this matter, remembering the diverse experience of so many firms who can speak from years of experience on both sides. On more than one occasion firms have abandoned the system of specially prepared catalogs, after prolonged experiment, as being an expense without adequate returns.

Classes of Machinery Not Well Adapted to Cataloging

Makers of paper-making machinery, for instance, may not find the suggestion helpful, such machinery having often to be built to suit special requirements. Indeed, one such firm some years ago did issue a catalog in the English language, and soon found that it was out of date in consequence of the rapid changes and improvements effected in such machines. Further, the people who received such catalogs would write for explanations and descriptions to meet the requirements of their case, particulars which could necessarily not be incorporated in any catalog. It is by no means an easy matter to illustrate properly and describe complete paper-making machines, or, indeed, most other complex machinery. It is generally found necessary to get into personal touch with prospective purchasers, go into all the details, and then get them up specifications for machinery to meet their requirements.

Take, again, another class of productions, such as steam shovels, ballast unloaders, dredges and ditchers, and general excavating machinery; the requirements must be considered before a suitable machine can be recommended for the work; and in some instances, particularly in the line of dredges and ditchers, the machinery has to be modified or changed in some minor respects to suit the local needs. Consequently the requirements must first be fully understood by the makers before an intelligent recommendation of a suitable machine can be made; and a catalog can, of course, only give standard machinery. For such special classes of manufacture it is certainly found better to send an ordinary catalog printed in English, which can be translated with the facilities at hand for such work at this time without any material expense or trouble on the part of intending purchasers. This is followed by a correspondence, and then the manufacturers can make themselves fully acquainted with the exact details of the required plant. If it is not possible for the makers to write in the language of their customers each side can write in their own language and the letters can be translated at each end. This method is found to answer well.

Better to Send No Catalogs Than to Send Poor Ones

Although opinions may be divided as to the expediency or otherwise of issuing special translations of catalogs for foreign trade, yet there can be no division of opinion among intelligent people as to the necessity, if such work is undertaken, of doing it thoroughly. It is ten thousand times better to leave it alone than to circulate a badly translated, poorly illustrated, and inadequate publication. By "adequate" I mean that it must contain full information about the specialties you are offering. Give too much information, if possible, rather than too little. People simply won't be bothered nowadays to write you thousands of miles for "further particulars," which should have been found within the pages before them. Give such data as to enable prospective buyers to judge whether the machinery described will meet their needs; also, how much it will cost delivered at the port nearest their works. Remember that you are the seller and that it is your business to facilitate matters and to render negotiations as smooth as possible. A good foreign catalog cannot be issued without costing a substantial sum of money. And that is only one of the items of expenditure. But a bad catalog will create a strong prejudice against the publishers, which they will find very awkward at a later date. As to whether prices should be included in the publication, this is a matter which must be left to each individual firm. Here again there is much difference of opinion; but it must be said that the recipient of a catalog ought, as a matter of common-sense, to be put into the position of knowing approximately what the goods he is asked to buy will cost him. That at least seems clear. But do not make the serious mistake of sending wholesale catalogs (i.e., lists intended for wholesale buyers only) to retail merchants. If you do you will eventually find the wholesale houses shut against you in a very unpleasant way. F. C. C.

The Two-tail Dog

Professor Sweet, being interviewed on the question of the two-tail dog, illustrated in the American Machinist at page 251, Vol. 29, Part 1, seemed to get on his fighting armor and delivered himself of the following:

"When I sent you the drawing of the two-tail dog I expect it was more in self-glorification than anything else. I simply thought I had accomplished a mechanical trick that many had tried, in a more simple way than any of them; but there is more to it than this, and a principle involved that likely few have thought of. In the use of the single-tail dog the work is driven by the dog and the live center of the lathe, the live center doing just as much of the driving, on an average, as the dog, and having to stand twice as much strain, on an average, when the dog is on the back side, as the dog itself. The lathe center being beveled, an end thrust is put on the tailstock. With the two-tail dog, the live center has nothing to do but resist the force of the cut.

"In practice the two-tail dog does more than anticipated. I had my doubts about its driving power; but its use on a geared-head lathe at the works of the Engelberg-Huller Company demonstrated that, while the common dog would not drive equal to the power of the lathe, the new one stalled it. At the works of our company the men find that they can turn pistons by driving from the end of the rod or turn commutators by the armature shafts without chatter.

"And so, too, H. J. Leighton, the builder of the prize-winner of gasolene yachts, says in the turning of crank-shafts he could never do the work with the common dog that he can do with the new one. In this the facts equal the theory.

"Will they ever be used? you ask. No! Not to any extent. They will cost perhaps 10 per cent. more; most machinists will make an awful job in putting them on the work, while, by going at it the right way, it is as easy as any; and, besides, they can be used wrong, which a large majority would do, and make them a nuisance. So the old one, wrong in every way, except easy to put on, will go on chattering the job every time it gets a chance.'"

New Publications

Crucibles, Their Care and Use. By John A. Walker. 39 6x9-inch pages. The Jos. Dixon Crucible Company, Jersey City, N. J.

This fine specimen of printing and engraving has been put out by the Dixon Crucible Company in order to instruct the users of crucibles in their proper management and care. Naturally the pamphlet contains a fund of information of immediate value to all crucible users.

Henley's Twentieth Century Book of Recipes, Formulas and Processes. Edited by Gardner D. Hiscox. 787 6x9-inch pages. The Norman W. Henley Publishing Company, New York. Price, in cloth, $3; in morocco, $4.

It is scarcely possible for any reviewer to critically examine a book of the im-

mense scope of this one, and one has natural doubts about the ability of any one compiler to prepare it. The preparation of such a book would seem to require the coöperation of a good many specialists, rather than the gathering together of material from all sources by any one man.

THE RAILROAD POCKETBOOK. By Fred H. Colvin. 197 4x6-inch pages, with numerous illustrations and tables. The Derry-Collard Company, New York. The Locomotive Publishing Company, London. Price, $1.

This little book may be described as, primarily, an illustrated railroad dictionary. It is, however, much more than that, as it gives a great variety of railroad data such as many of the Master Car Builders' standards, the results of tests, the leading proportions of boilers and locomotives, and various other rules and data. It gives a very large amount of information in very condensed form, and is useful to every railroad man.

MODERN STEAM ENGINEERING IN THEORY AND PRACTICE. By Gardner D. Hiscox. 487 6x9-inch pages; with 405 illustrations. The Norman W. Henley Publishing Company, New York. Price, $3.

Mr. Hiscox seems to think he has a mission to write books, but we doubt it. The present book is attractive to the eye at first glance, but the more one examines it, the less he finds in it. It is nothing but a compilation, and a poor one at that, the sources from which the information is obtained being sometimes given, and sometimes omitted. The book has the appearance of having been made to order and has the degree of merit that commonly goes with books of that class.

AIR BRAKE CATECHISM. By Robert H. Blackall. 367 pages, 5x7¼ inches. 130 illustrations and folding plates. The Norman W. Henley Publishing Company, New York. Price, $2.

The extensive use of the air brake and the demand for information concerning it are shown by the fact that this book is now in its twenty-first edition. Railroad men seem to like the catechism style, and this gives nearly two thousand questions and answers on the Westinghouse system, including the new "ET" equipment, which combines straight air and automatic for use on locomotive and tender in simpler manner than ever before, and in a way that is easier to maintain. It also shows the new triple valve for freight service and the cross-compound air pump, made necessary by the longer and heavier trains which require a large volume of air. The two colored charts make clear some of the workings which would otherwise be somewhat hazy and altogether it is the most complete book in print on this system of air brakes.

THE MANUFACTURE AND PROPERTIES OF IRON AND STEEL. Fourth edition. By H. H. Campbell. 639 6x9-inch pages, with numerous illustrations and tables. The Hill Publishing Company, New York and London. Price, $5.

While intended primarily for the metallurgical engineer, this volume is entitled to a place in the libraries of engineers in general. It is divided into three parts, of which the first is an introduction intended for those who are not metallurgists. The second is more technical, and after a description of the primitive methods of making iron, takes up the various processes as practiced today and includes chapters on heat treatment, the history and shape of the test piece, the influence of certain elements on the physical properties of steel and steel castings. Part III is devoted to the iron industry of the leading nations and outlines the practice of the leading iron-making countries. The new edition has been extensively revised and is brought thoroughly up to date.

LOCOMOTIVES, SIMPLE, COMPOUND AND ELECTRIC. By H. C. Reagan. 917 pages, 5½x8 inches; 494 illustrations. John Wiley & Sons, New York. Price, $3.50.

This is the fifth edition of this book, and the number of pages has been increased from 617 to the present number, while the illustrations in the former editions numbered 309. This surely justifies the advance in price from $2.50 to the amount named. The revision takes up the development of the steam locomotive, including the four-cylinder compound and steam superheater. Compounds of two, three and four cylinders are shown, and include both American and foreign practice. The use of the electric locomotive for trunk lines is shown in considerable detail, together with the apparatus needed for the generation and transmission of the electric current for operating the locomotive. This includes the single-phase system, using single-phase motors; the poly-phase system, using induction motors; the three-phase system of generation and transmission, using rotary converters with direct-current motors on the locomotive; and the three-wire direct current system, together with the simple direct-current system, using a trolley and ground return. It also shows the various methods of control and electric braking apparatus. Then there is a chapter on gasolene-electric locomotives, which is one of the later developments, and which are reported to be in successful use on small feeder lines in connection with some of the large railway systems. We do not know of any book which contains such an amount of information for those who are interested in the motive power of railroads, and this should be a welcome addition to their library for reading and reference.

NOTES ET FORMULES DE L'INGENIEUR ET DU CONSTRUCTEUR-MECANICIEN; MATHEMATIQUES, MECANIQUE, ELECTRICITE, CHEMINS DE FER, MINES, METALLURGIE, ETC. By a committee of engineers under the direction of Ch. Vigreux, engineer of arts and manufactures, Ch. Milandre, civil engineer, and R. P. Bouquet, electrical engineer. Fifteenth edition, revised, corrected and considerably enlarged; 1982 pages, 4¼x6¾ inches; about 1500 illustrations. E. Bernard, 1, Rue de Médicis, Paris.

This book, to the French engineer, fills a place similar to that of "Hütte" (reviewed at page 757, Vol. 29, Part 1) to the German. Its popularity is well attested by the fact that 120,000 have been issued. This edition contains 164 pages more than the fourteenth edition, published in 1905, and about 150 more cuts. There is not space to state even a quarter of the contents of these nearly 2000 pages, we can merely mention a few of the subjects of which the treatment has been improved over the previous edition. The tables of natural trigonometrical functions now have five decimal places instead of three; in the section on algebra the methods of solving equations of the third and fourth degrees are given; there is a series of diagrams of various plane figures with the locations of their centers of gravity; the treatment of springs, elliptical and spiral, is quite full, wherein the influence of the automobile may be perceived; formulas of Lamé for the strength of cylindrical and spherical vessels; bolts and nuts; practical formulas for the calculation of shafts; new matter on belts, steam boilers, cast-iron pipes, and hydraulic experiments have been added. The chapters on turbines, hoisting apparatus and metallurgy have been entirely rewritten and are quite full. Among other subjects upon which chapters have been added are blast-furnace gas in the section on hydrocarbon motors, electrochemistry, purification of water, automobiles, mines, etc. The space assigned to the steam turbine (four pages) scarcely seems in proportion to the attention this motor is now attracting; apparently the De Laval steam turbine is the only one illustrated. The technical dictionary, in three languages (130 pages), is a useful feature, being arranged in three parts, viz., French-English-German; English-French; and German-French. To add to its convenience, the French words throughout are printed in Egyptian type; the English in italic, and the German in Roman. Criticisms and corrections of this dictionary are invited by the publishers.

REPORT OF THE MASSACHUSETTS COMMISSION ON INDUSTRIAL AND TECHNICAL EDUCATION. 196 6x9 inch pages. Teachers' College, Columbia University, New York. Price, 50 cents.

Much has been heard of late about the

report of which this pamphlet is a reprint, and an examination of it justifies the best that has been said of it. It is of an eminently practical and commonsense character and begins with a brief historical inquiry, in which it is shown that the movement toward industrial training is not a departure from the previous trend of educational progress, but on the contrary, that it is distinctly in line with that progress. Vocational training, as it is here called, began with theology, medicine and law, and continued to civil and later to other branches of engineering.

Industrial education in Europe is of course, discussed at considerable length, and if anything more were needed to convince the average American citizen of our inferiority in this field of work, this report would supply the deficiency.

The unique feature of the work of the commission is the report of a sub-committee who made a most painstaking inquiry into the actual conditions of children between 14 and 16 years of age, over 5000 such children having been followed into their homes and the factories where they are employed. The striking generalization is made that the withdrawal of the children from school life at about 14 years of age or less, is not in general due to the necessities of the parents, but to the unwillingness of the children to continue at school. The inevitable conclusion is that this withdrawal is due to the fact that the schools as now organized have no further attractions for the pupils. On the other hand, it is very clearly determined that in spite of the unfitness of public-school training to modern industrial conditions, the remaining years of school life are of great value to those who continue at school, as the fact is demonstrated that those who begin factory life at 16 overtake those beginning at 14 in the matter of wages in less than two years. The hearings and inquiries of the commission have shown that there exists in Massachusetts an overwhelming demand for the establishment of industrial schools.

The report concludes with several appendices on industrial education in Europe, and especially on the industrial schools of England, this latter appendix having been supplied by Sir William Mather, M. P., of Manchester. The pamphlet should be in the hands of every one who takes any interest in this great movement and the Teachers' College has done a distinct service both to the public and to this movement in re-printing this report and in placing it within the reach of all.

Obituary

John Joseph Riley, owner of the Brooklyn Steam Engine Works, Brooklyn, died on Monday, April 1, at Lakewood, N. J. Mr. Riley was born August 14, 1846, and had lived in Brooklyn since a boy. He was one of the founders of the Modern Science Club of Brooklyn, a member of the New York and New Jersey Foundrymen's Association, and National Association of Foundrymen.

Business Items

Monsieur Ronceray, of Ph. Bonvillain & E. Ronceray, Paris, machine tool importers and manufacturers of molding machines, expects to leave Havre April 13, with the view of presenting his firm's machines at the American Foundrymen's Association exhibition, Philadelphia, May 20 to 24. He will visit the principal machine-tool manufacturers, to establish connections for the sale of their machines in Europe.

Trade Catalogs

The Akron Clutch Company, Akron, Ohio. Catalog of Akron friction clutch. Illustrated, 18 pages, 3½x6 inches, paper.

Massachusetts Saw Works, Chicopee, Mass. Price List No. 10, Victor hack saw, blades and frames. Illustrated, 26 pages, 3½x6 inches, paper.

The Cleveland Twist Drill Company, Cleveland, O. Catalog No. 33, describing Paradox adjustable reamers. Illustrated, 8 pages, 6x9 inches, paper.

American File Sharpener Company, 296 Broadway, New York. Catalog describing file sharpening machine. Illustrated, 24 pages, 5x8 inches, paper.

Baldwin Locomotive Works, Philadelphia, Penn. Record No. 60. The Actual Efficiency of a Modern Locomotive. Illustrated, 32 pages, 6x9 inches, paper.

The J. Geo. Leyner Engineering Works Company, Littleton, Colo. Bulletin No. 510, describing steam and electric geared hoists. Illustrated, 56 pages, 6x9 inches, paper.

The Westinghouse Machine Company, E. Pittsburg, Penn. Catalog describing Westinghouse storage battery for stationary use. Illustrated, 31 pages, 6x9 inches, paper.

The Robertson Manufacturing Company, Incorporated, 1459 Niagara street, Buffalo, N. Y. Catalog of rapid cut power saws. Illustrated, 13 pages, 3½x6 inches, paper.

Abenaque Machine Works, Westminster Station, Vt. Catalog of gas or gasolene driven direct connected air compressor outfits. Illustrated, 8 pages, 6x9 inches, paper.

The J. D. Smith Foundry Supply Company, Cleveland, Ohio. Catalog and price list No. 37 describing foundry facings, supplies and equipment. Illustrated, 6x9 inches, 260 pages, paper.

Philadelphia Gear Works, 125-127 North Seventh street, Philadelphia, Penn. Catalog of gears with rules and tables for figuring same. Illustrated, 72 pages, 6x9 inches, paper.

United Engineering and Foundry Company, Pittsburg, Penn. Pamphlet containing list of users of lever shears and vertical shears, also letters of testimonial. 52 pages, 3½x6 inches.

Keuffel & Esser Company, 127 Fulton street, New York. Circulars illustrating and describing Keuffel & Esser automatic print hanger, folding rules and Sperry's pocket calculator.

The Robertson Manufacturing Company, Buffalo N. Y. Catalog of rapid cut power saws, drill presses, emery grinders and gas and gasolene engines. Illustrated, 16 pages, 3½x6 inches, paper.

U. S. Metallic Packing Company, 429 North Thirteenth street, Philadelphia, Penn. Catalog of metallic packings for marine and stationary engines. Illustrated, 16 pages, 3½x6 inches, paper.

Emerson Electrical Manufacturing Company, St. Louis, Mo. Bulletins, Nos. 3111 to 3122, illustrating and describing single-phase induction motors. Pocket Price Book No. 9, dated February 20, 1907.

Wells Brothers Company, Greenfield, Mass. Catalog No. 22, describing complete line of screw cutting tools and machinery, including a number of new ones. Illustrated, 251 pages, 5x7½ inches, paper.

The Smith & Winchester Manufacturing Company, South Windham, Conn. Catalog B, describing friction clutches, paper cutters, paper bag machines, etc. Illustrated, 39 pages, 5½x8 inches, paper.

Montgomery & Company, 105-107 Fulton street, New York. Tool catalog No. 25. Illustrated, 336 pages, 5x6½ inches, paper. This will be sent gratis to anyone interested on application to the company.

Reinforced Cement Construction Company, 1 Madison avenue, New York. Booklet containing illustrations showing progress of the construction of a nine-story apartment house built of reinforced concrete.

Cutler-Hammer Manufacturing Company, Milwaukee, Wis. Pamphlet entitled "A Tale of Two Types" which is a comparison of ventilated and enclosed starting boxes. Illustrated, 11 pages, 6x9 inches, paper.

Armstrong Bros. Tool Company, 104-124 N. Francisco avenue, Chicago, Ill. Catalog No. 14, describing tool holders and other machine shop specialties, including cutting-off and grinding machine, ratchets, etc. Illustrated, 80 pages, 3½x6 inches, paper.

Emerson Electric Manufacturing Company, St. Louis, Mo. Catalog No. 4490, describing desk fans for direct current. Illustrated, 16 pages, 5x7½ inches. Catalog No. 4470, describing Trojan fans for alternating current. Illustrated, 32 pages, 5½x7 inches. Catalog No. 4460, describing Emerson fans for alternating current. Illustrated, 48 pages, 5½x7 inches.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E. G. Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Tools, dies and machinery built to order. Northwestern Machine Co., Detroit, Mich.

Expert machinist will consult and give advice. A. Frisk, 2240 Van Buren St., Chicago.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery to order, carbon and other molds specialty. O. Anderson, 30 Lawrence St., Newark, N. J.

Wanted—Tapping chuck, 0" to ⅝"; also horizontal broach, in good order; state make price. Box 3512, Philadelphia, Pa.

Special machinery, toolmakers, screw machine products and manufacturers. Gierth &

Richards, 251-255 Elm St., Newark, N. J.

Wanted—Manufacturer to build in quantities, a new type of standard machine (compressor) in steady demand. Address R. C. Co., Box 821, Pittsburg, Pa.

Small automatic machinery for special work, models, jigs, etc., built to order. Satisfaction guaranteed. Novelty Engineering Association, Box 264, Fitchburg, Mass.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Large floors for rent, 60x210 ft. in thriving country town near Boston and Providence; steam and electric power, light and heat; railroad switch. Apply to Box 773, AMERICAN MACHINIST.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Partner Wanted—Active preferred, having from $25,000 to $50,000 to invest in manufacturing concrete machinery; want capital to execute profitable orders; full investigation invited. Box 856, AMER. MACHINIST.

Partner Wanted—Will give owner of jobbing foundry or metal pattern works one-half interest in attachment for ladies if they will pay for cost of patent in Canada; plant must be located in Canada. Address Box 837, AMERICAN MACHINIST.

Wanted—To buy patent, or manufacture under royalty, any specialty where high-grade grey iron castings constitute 60 per cent. or more of total cost; would also consider New England or Eastern rights to established article. "Founder," Care AMER. MACHINIST.

Draftsman, engineers learn automobile drafting and designing including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

The shops of the Motor Car Specialty Company, at Trenton, N. J., in addition to building speed meters and other high-class speed recording instruments, are open for the manufacture of light high-grade machinery, on contract or royalty basis, either in large or small quantities.

An experienced designer desires to negotiate with responsible concern desiring to manufacture gasolene commercial vehicles to design for them a commercial truck or delivery wagon, which will be a practical success without experimenting. Address Box 808, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

We build machines or parts on rush orders. A modern shop equipped with milling machines, drill presses, universal grinders, stamping press, automatic screw cutting machine and lathes, will take contracts for the quick delivery of articles that can be built in such a shop. Send drawings and specifications or sample and estimates will be returned with guarantee of quick delivery. We also build models and do experimental work. Address Box 830, AMERICAN MACHINIST.

Successful draftsmen drawing $125 to $200 monthly require thorough drafting room knowledge. As chief draftsman of engineering firm I know exactly the quality and quantity of experience and practical training you must have, and prepare you by mail, home instructions for above paying positions, which I furnish free anywhere. Complete highest grade drawing outfit, with German silver set of tools, value $13.85, free. Address Chief Draftsman, Div. 4, The Engineers' Equipment Co., (Inc.), Chicago.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Mechanical draftsman; German graduate; age 25; 6 years' experience in shop and drafting room, working with a machine tool concern desires change; best references. Box 841, AMERICAN MACHINIST.

Superintendent wishes to make a change, accustomed to fine and medium heavy interchangeable work; a designer of modern tools, jigs, and special machinery for rapid production. Box 784, AMERICAN MACHINIST.

ILLINOIS

Draftsman—Engineer in charge of large drafting room in the West wants work in the East. Box 776, AMERICAN MACHINIST.

Draftsman; competent and reliable mechanical or patent office; six years' experience; American; 26. Box 843, AMER. MACH.

Wanted—Position as foreman patternmaker; A-1 references; 10 years' experience in some of the best shops in the country. Box 835, AMERICAN MACHINIST.

Wanted—Position as superintendent of foundry and pattern shop; can give the best of reference and am familiar with methods that produce results. Address Box 836, AM. M.

INDIANA

Foreman toolmaker and machinist; 35; desires change; 12 years in charge of tool rooms and machine shops; have good command of men; work to the best advantage. Box 827, AMERICAN MACHINIST.

MASSACHUSETTS

Blacksmith foreman desires change. Box 800, AMERICAN MACHINIST.

Mechanical draftsman, 30 years old, technical graduate, extensive experience in drafting room and shop, wishes position. Box 829, AMERICAN MACHINIST.

Wanted—Charge of a machine shop or department by man experienced and successful in manufacturing; has had special experience on tool work. Box 849, AM. M.

Position as superintendent or assistant; 16 years 'experience from machinist to present position in charge of factory employing 120; familiar with best present day methods; practical, systematic and energetic; age 36. Address Box 847, AMERICAN MACHINIST.

NEW JERSEY

Draftsman; conversant with developing of special machinery desires situation; New York or vicinity preferred. Box 851, AM. M.

M. E., college graduate, experienced in layouts of plans for industrial plants, in detailing and structural work; able in figuring; desirous of change. Box 833, AMER. MACH.

Draftsman; mechanical; 3 years', 10 months' machinist apprentice; experienced in boiler and general machine work; desires position as draftsman or erector. "W. W." Box 845, AMERICAN MACHINIST.

NEW YORK

Mechanical engineer; graduate; age 26; 3 years' drafting and shop experience; desires change. Box 846, AMER. MACHINIST.

Mechanical draftsman wishes to change position; six years' practical experience and technical training. Box 831, AMER. MACH.

Draftsman; mechanical engineer; 29 years of age; highest references; is open for engagement. Box 852, AMERICAN MACHINIST.

Master mechanic; 25 years' experience on machinery, tools and instrument work; desires position in New York or New Jersey. Address Box 840, AMERICAN MACHINIST.

Draftsman; 5 years' experience; 2 years shop work; student in engineering at Cooper Institute; wishes position in New York or New Jersey. Box 850, AMERICAN MACHINIST.

Mechanical engineer and draftsman; graduate German; age 25; 4 years' experience; desires change; New York or New Jersey preferred. Box 822, AMERICAN MACHINIST.

Designing draftsman; American; age 32; technical graduate; desires position with master mechanic; on jigs, fixtures, or automatic machines. Box 853, AMER. MACH.

Steam turbine; experienced engineer and designer; 6 years with first-class English firms; wants rsponsible position or introduce this engine. Address Box 839, AM. MACH.

Superintendent; age 37; wide experience on interchangeable work, special machinery and metal specialties; executive ability and excellent manager of men. Address Box 802, AMERICAN MACHINIST.

Mechanical superintendent, employed, desires to make a change; expert toolmaker, machinist, designer and manufacturing economist; strong executive; salary secondary consideration. Box 795, AMERICAN MACHINIST.

PENNSYLVANIA

Superintendent, shop manager; high-grade factory executive, wants to change; west or south preferred. Box 834, AMER. MACH.

Wanted—Position as superintendent or shop manager; technical and practical training of 22 years; designed, built and equipped three modern plants; good organizer, systematizer and up to date on modern methods of production. Box 828, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

GEORGIA

Wanted—Machinists to work in one of the best shops in Atlanta; good places for good men; open shop. E. Van Winkle Gin & Machine Works, Atlanta, Ga.

ILLINOIS

Wanted—Foreman in the jobbing and special order department of large sheet metal works; department embraces light and heavy sheet metal of all description; applicant must have large experience and executive ability; German preferred; salary $1500. Address Box 803, AMERICAN MACHINIST.

Wanted—Young man, who is a thorough shop man, to travel for a machine tool concern in the East; good opening for man not over 35, who is not afraid of hard work; not necessary to have had any experience as salesman, although such an experience would help. Address Box 815. AMER. MACHINIST.

INDIANA

Wanted—Toolmakers; lathe hands, and assemblers; good wages; steady employment; Western Motor Co., Logansport, Ind.

MARYLAND

Wanted—By established automobile manufacturer, an experienced engineer and designer competent to design a four-cylinder gasolene touring car both with respect to desirability and economical production; good position with excellent opportunities for right man; give experience in reply. Address "Engineer," AMERICAN MACHINIST.

MASSACHUSETTS

Good mechanical draftsman for design of measuring instruments wanted by manufacturing concern near Boston; address with full information regarding age, education, experience and salary expected to Box 838, AM. M.

Wanted—A working superintendent for factory in Boston, manufacturing special machinery now employing upwards one hundred men; must have had best of experience in first-class shops; an excellent opportunity for good man. Box 854, AMERICAN MACHINIST.

Wanted—Tool and die makers accustomed to accurate, complicated work; steady work to thoroughly competent men; wages 40c. per hour subject to a liberal increase after showing the necessary ability; give references. Address The D. F. Briggs Co., Manufacturing Jewelers, Attleboro, Mass.

Wanted—Young machinist who has had drafting room experience to be assistant manager of a plant building fine machinery; must be sober, honest, willing to work hard; exceptional chance and interest in business to any one who can prove his ability; give age, experience and references. Box 832, AMERICAN MACHINIST.

MICHIGAN

Machinists Wanted—First-class machine hands and floor hands on heavy work; steady employment assured. Northern Engineering Works, Detroit, Mich.

MISSOURI

Wanted—First-class adjusters accustomed to adding machine and typewriter work. Universal Adding Machine Co., St. Louis.

NEW JERSEY

Gas engine man wanted at once for installation and repair work. Steady employment. Apply, The Standard Motor Construction Co., 172 Whiton St., Jersey City, N. J.

Wanted—Tool, die and instrument makers accustomed to accurate, complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Wanted—Foreman for foundry; open shop employing about fifteen molders, making machinery castings up to two tons; permanent position to reliable and capable man; state references, age and salary wanted. Address Box 811, AMERICAN MACHINIST.

Wanted—An experienced foreman of toolmaking department in a factory producing fine small mechanical work, on the interchangeable plan; the work done demands the highest skill and accuracy in fine tool work. An intimate knowledge of fine die and sub-

press work and modern up-to-date methods in all departments of fine tool making; it is absolutely essential that the applicant should have held a similar position elsewhere, and be possessed of good executive ability; the department employs from 30 to 40 men; references required. Box 789, AMER. MACH.

NEW YORK

Wanted—Patternmaker at McEwen Bros., Wellsville, N. Y.

Wanted—Experienced diemaker on drop-forging dies. Box 842, AMER. MACHINIST.

Blacksmith foreman; must be first-class, practical and up to date in every particular. Address Box 826, AMERICAN MACHINIST.

Wanted—Experienced draftsman, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted—Young man familiar with power transmission machinery; state age, experience and salary expected. Address P. O. Box 2062, New York.

Wanted—At once, two experienced tracers for machine and fine tool drawings. Give age, experience and wages expected. Remington Arms Company, Ilion, N. Y.

Patternmaker—An unusually favorable opening for the right man; position permanent with good wages; man must be steady, sober and reliable. State wages and experience. Box 848, AMER. MACHINIST.

Foundry foreman; western New York; general line; one pound to five tons, new modern foundry; melting 20 tons, wants up-to-date man who can show he has produced results; state in full, name, age, experiences, references and salary wanted to start. Address "Foundry," AMERICAN MACHINIST.

Wanted—Draftsman capable of designing small machinery and proportioning details; one familiar with automatic feed, roll, disc, hopper, etc.; also capable of laying out sheet metal dies for blanking and forming; state age; married or single; reference and salary expected; factory located in Brooklyn. Address "E. B. P.," AMERICAN MACHINIST.

Competent factory executive wanted; Western New York Manufacturing Company, manufacturing large line from medium interchangeabe parts by automatic and semi-automatic machinery to large special units; capable man of high character, tact and experience in manufacturing lines with ability and business sense, who can show that he has produced results, and has capacity to rapidly advance to an executive position; state in full, name, age, past experiences, length of time different positions, responsibilities, references, etc. Address "Capable," AMERICAN MACHINIST.

OHIO

Wanted—Technical graduate experienced on gas engines, to take charge of gas engine testing department of large works. Address, giving full particulars. Box 157, Salem, O.

Wanted—Mechanical drawing checker; an experienced practical and reliable man, age 30 or more, wanted by a large automobile manufacturer; must be experienced and have good mechanical ability to check drawings, see that parts will assemble without interference, and make estimates of material required in construction; permanent position and good salary for right man; references. Address Box 801, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—First-class draftsman on mill construction and equipment, technical man preferred. Box 775, AMERICAN MACHINIST.

Wanted—Capable diemakers to work on heavy drop-forge dies; steady work for the proper applicants. Apply, giving references, as well as wages expected. Box 705, AM. M.

Wanted—Foreman for erecting floor, on medium heavy machinery; applicant must have large experience, and executive ability; German preferred, but not necessary. State age, references and salary wanted. Box 844, AMERICAN MACHINIST.

Wanted—First-class automatic screw machine operator who is capable to cam up new jobs on Cleveland automatic screw machines, design tools for the operation, and who can keep machnes in repair. Must be first-class toolmaker and capable of handling men; will have charge of twenty-four 2" and 2¼" machines and also of toolroom; only first-class man should apply Address, giving age, experience, and references, F. K. Landgraf, Bridgeville, Pa.

RHODE ISLAND

We are continually adding to our force, experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery. Good wages and steady employment. Apply to Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To correspond with men capable of filling positions as instructors in college machine, pattern, and forge shops; location, middle West; state age, full experience and education. Communication treated confidentially. Box 794, AMERICAN MACHINIST.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

Wanted—A good superintendent capable of handling pattern shop, foundry and machine shop departments in a general jobbing, repairing and manufacturing shop located in a rapidly growing city of two hundred thousand inhabitants, center of a big lumbering country in the West; one who could invest about $10,000 preferred. An excellent opening for the right man. Full investigation demanded and given. Address Box 692, AMER. MACH.

FOREIGN

Wanted—Gentleman (English or foreign), for technical correspondence and other office work; must be good linguist; state age, salary expected, and full particulars in own handwriting. Z. F., 699, Messrs. Deacons, Leadenhall Street, London, England.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Jobbing iron and brass foundry, located in western Pennsylvania; price $6000. Address Box 813, AMERICAN MACHINIST.

An established engine lathe business in city of 50,000; reasons to enlarge foundry and limit business to that branch. Address Box 645, Springfield, Ohio.

For Sale—Cyclopedia of modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—Plant suitable for machine shop and foundry. Splendid location, New York State. Good shipping point. Would take part interest in good manufacturing enterprise. E. W. Fulton, Lowville, N. Y.

For Sale—Practically new Pratt & Whitney 9" Pillar shaper, cutter head having stroke of 10"; in excellent condition; reason for selling too small range for our work. Address Box 855, AMERICAN MACHINIST.

For Sale or for rent; small foundry and machine shop doing good business; excellent opportunity for combined business and foundryman; located in manufacturing district eastern New York. Box 809, AMER. MACH.

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Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

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Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cochrane-Bly Co., Rochester, N.Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Ballinger & Perrot, Phila., Pa.
Dodge & Day, Philadelphia, Pa.

Barrels Steel

Kilbourne & Jacobs Mfg. Co., Columbus, Ohio.
Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Baird Machine Co., Oakville, Ct.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Elmes Engineering Works, Chas. F., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hess-Bright Mfg. Co., Phila., Pa.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Schieren & Co., Chas. A., New York.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

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Blowers

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Soltmann, E. G., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Brown & Co., H. B., East Hampton, Conn.
Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
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Northern Elec. Mfg Co., Madison, Wis.
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Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Mfg. Co., G. M., Mechanicsburg, Pa.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Sames, C. M., Jersey City, N. J.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
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Beaman & Smith Co., Prov., R. I.
Bertam & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
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Kern Machine Tool Co., Cincinnati, Ohio.
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Motch & Merryweather Machinery Co., Cleveland, O.
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Vandyck Churchill Co., New York.
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Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
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Ridgway Dynamo & Engine Co., Ridgway, Pa.
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Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Carr Bros., Syracuse, N. Y.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

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Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburgh, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings, Motor
Shaw Mfg. Co., Galesburg, Kan.

Castings Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Phœnix Mfg. Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.

Chucking Machines—*Cont.*
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown Co., R H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
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Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Mfg. Co., G. M., Mechanicsburg, Pa.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
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Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Tudor Mfg. Co., Worcester, Mass.

Clutches, Friction
American Tool & Machine Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic
Sturtevant Co., B. F., Boston, Mass.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Cutting
New York Lubricating Oil Co., New York.

Compound, Slushing
Warren Bros. Co., Boston, Mass.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Leard, Wm. E, New Brighton, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Machine Co., Boston, Mass.
Chapman & Co., J. B., Springfield, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Bertram & Sons Co, Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Corundum
See Grinding Wheels

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters Machinery
Veeder Mfg. Co., Hartford, Ct.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Cresson Co., Geo. V., Phila., Pa.
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Leard, Wm. E., New Brighton, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Cyclometers

Veeder Mfg. Co., Hartford, Ct.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York City.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press

Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Mittineague Paper Co., Mittineague, Mass.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Contes Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.

Drilling Machines, Radial —*Continued.*

Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co, New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Burke Mchry. Co., Cleveland, O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc, Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center

Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Contes Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

Amedican Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York City.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Consulting, and Mechanical

Ballinger & Perrot, Philadelphia, Pa.
Dodge & Day, Philadelphia, Pa.
Thompson, Hugh L., Waterbury, Conn.

Engineers, Electrical

Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Shaw Mfg. Co., Galesburg, Kan.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Foos Gas Engine Co., Springfield, Ohio.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
New Era Gas Engine Co., Dayton, O.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers

Bormay Engraving Co., New York.
Standard Engraving Co., New York.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Machinery Exchange, Boston, Mass.
Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric

Backus Water Motor Co., Newark, N. J.
Crocker-Wheeer Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Backus Water Motor Co., Newark, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co, New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Mchy. Co., Cleveland, O.
Gem Mfg. Co., Pittsburg, Pa.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co, Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers

Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Fexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Turner Brass Works, Chicago, Ill.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters

Sturtevant Co., B. F., Hyde Park, Mass.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co, L. S., Athol, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros., Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

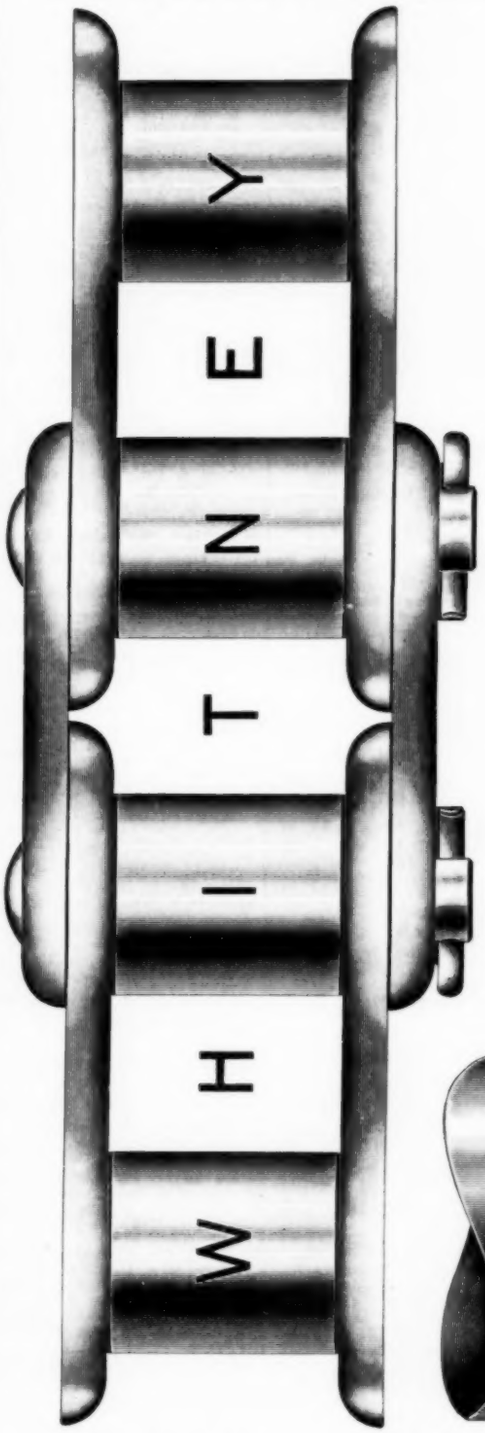
Gears, Cut

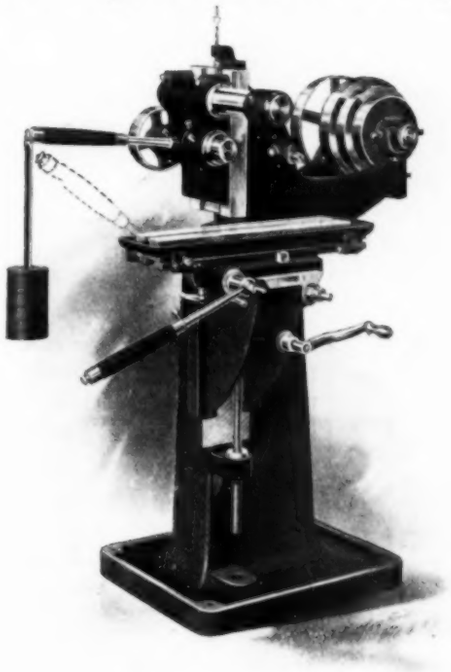
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa. delphia, Pa.
Earle Gear & Machine Co., Phila.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Morse, Williams & Co., Phila., Pa.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.

"WHITNEY" CHAINS

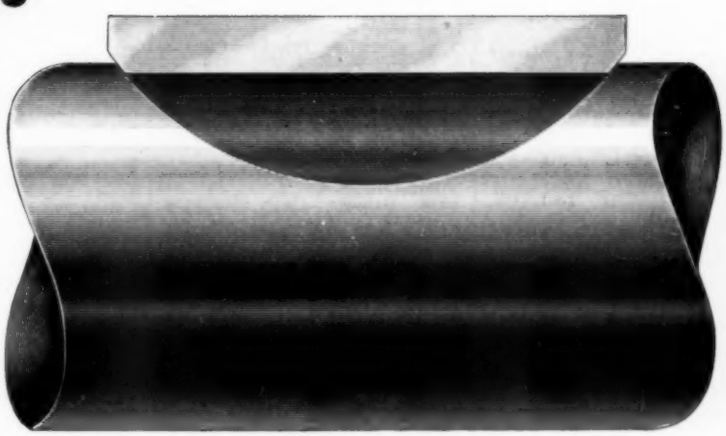
Hand (feed) Milling Machines

The Woodruff Patent System of Keying





The New Model.



The Whitney Mfg. Co., Hartford, Conn., U.S.A.

Gears, Cut—*Continued.*
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees-Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas
American Gas Furnace Co., New York.

Gibs
Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center
Cincinati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.

Grinders, Cutter—*Continued.*
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Machine Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Iroquois Mach. Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Grinders, Tool
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding and Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Mchry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Goodell-Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Prov., R. I.
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Iroquois Mach. Co., New York.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

Grinding Wheels
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Diamond Mach. Co., Prov., R. I.
Hampden Corundum Wheel Co., Brightwood, Mass.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Niles-Bement-Pond Co., New York.
Pike Mfg. Co., Pike, N. H.

Gun Barrel Machinery
Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.

Hammers, Drop—*Continued.*
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Ct.

Hammers, Steam
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Erie Foundry Co., Erie, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Cresson Co., Geo. V., Phila., Pa.
Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

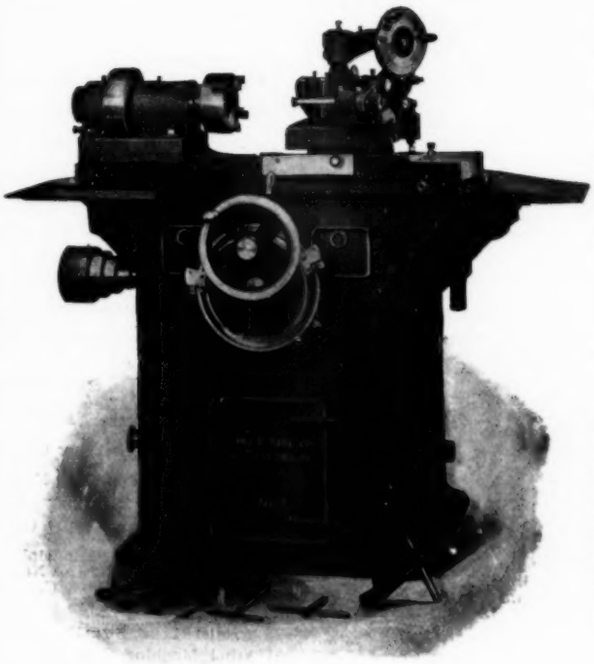
Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Cresson Co., Geo. V., Phila., Pa.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Boston, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.



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It means you will get work of real quality.

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The use of COLD PUNCHED NUTS, Full Finished or Finished Case Hardened, "Milton" Brand, on your Machinery will guarantee to you the perfect finishing touches essential in rounding out a good first-class Machine or Tool in point of workmanship. In the manufacture of all styles of Cold Punched Nuts we use DOUBLE REFINED BAR IRON of our own manufacture, which is made uniform in quality. Our product is perfectly Hexagonal in shape, with sharp corners and well finished. The Finished Case Hardened Nuts show on their exterior surfaces in coloring The Works of Art. We will Gladly send samples for test and comparison upon request.

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Hoists, Electric —*Continued.*
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Chicago Pneumatic Tool Co., Chicago, Ill.
Pike Mfg. Co., Pike, N. H.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.
Rhoads & Son, J. E., Phila., Pa.
Sprague Electric Co., New York.

Hot Blast Apparatus
Sturtevant Co., B. F., Boston, Mass.

Igniters, Gas Engine
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed
Niagara Tachometer & Inst. Co., Niagara Falls, N. Y.
Starrett Co., L. S., Athol, Mass.

Indicators, Speed, Peripheral
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston, Mass.

Indicators, Test
Norton Co., Worcester, Mass.

Industrial Railways
Hunt Co., C. W., West New Brighton, N. Y.

Injectors
Desmond-Stephan Mfg. Co., Urbana, Ohio.
International Specialty Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

Inspection and Tests
Hunt Co., Robert W., Chicago, Ill.

Instruments, Electric
General Electric Co., New York.

Iron Bar
Milton Mfg. Co., Milton, Pa.

Jacks, Hydraulic
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Burroughs Co., Chas., Newark, N. J.
Joyce-Cridland Co., Dayton, O.
Watson-Stillman Co., New York.

Jacks, Planer
Armstrong Bros. Tool Co., Chicago, Ill.

Kettles, Soda
Brown & Sharpe Mfg. Co., Providence, R. I.
Mfg. Equip. & Engineering Co., E. Boston, Mass.

Key Seaters
Baker Bros., Toledo, O.
Chattanooga Machinery Co., Chattanooga, Tenn.
Lapointe Mach. Tool Co., Hudson, Mass.

Key Seaters —*Continued.*
Marshall & Huschart Machry. Co., Chicago, Ill.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Keys, Machine
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Knives, Machine
Coes Wrench Co., Worcester, Mass.

Knurls
Hammacher, Schlemmer & Co., New York.

Lamps, Arc
General Electric Co., New York.
Turner Brass Works, Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathe Attachments
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bradford Machine Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.

Lathe Dogs
American Tool & Machine Co., Boston, Mass.
Armstrong Bros. Tool Co., Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
LeCount, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.

Lathes
American Tool & Mach. Co., Boston. Mass.
American Tool Wks. Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, Rockford, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Champion Tool Works Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Diamond Mach. Co., Prov., R. I.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., Springfield, O.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Mach. Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Conn.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rahn-Carpenter Co., Cincinnati, Ohio.
Schumacher & Boye, Cincinnati, Ohio.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes —*Continued.*
Springfield Mach. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Wells Sons Co., F. E., Greenfield, Mass.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Lathes, Automatic Screw-Threading
Automatic Machine Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench
American Watch Tool Co., Waltham, Mass.
Blount Co., J. G., Everett, Mass.
Fenn Mach. Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloan & Chace Mfg. Co., Newark, N. J.
Waltham Machine Wks., Springfield, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Lathes, Brass
Bardons & Oliver, Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Dreses Mach. Tool Co., Cincin., O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Warner & Swasey Co., Cleveland, Ohio.
Windsor Mach. Co., Windsor, Vt.

Lathes, Extension
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power
Barnes Co., W. F. & Jno., Rockford, Ill.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Speed
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Blount Co., J. G., Everett, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Pulley
Kern Machine Tool Co., Cincinnati, Ohio.

Lathes, Wood
Prentiss Tool & Supply Co., New York.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Letters, Pattern
Butler, A. G., New York.

Levels
Starrett Co., L. S., Athol, Mass.

Lifting Magnets
Electric Controller & Supply Co., Cleveland, O.

Lockers, Clothes
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Merritt & Co., Philadelphia, Pa.

Locks
Yale & Towne Mfg. Co., New York.

Locomotives, Electric
General Electric Co., New York.

Lubricants
Besly & Co., Chas. H., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Dixon Crucible Co., Jos., Jersey City, N. J.
N. Y. Lubricating Oil Co., New York.

Lubricators
Besly & Co., Chas. H., Chicago, Ill.
Williams Valve Co., D. T., Cincinnati, O.

Machinery Dealers
Garvin Mach. Co., New York.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
McDowell, Stocker & Co., Chicago, Ill.
Motch & Merryweather Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mach. Co., C. C., Detroit, Mich.

Machinists' Small Tools
Athol Machine Co., Athol, Mass.
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hammacher, Schlemmer & Co., New York.
Millers Falls Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Machinists' Supplies
Bemis & Call Hardware & Tool Co., Springfield, Mass.
Hammacher, Schlemmer & Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Mandrels, Expanding
Le Count, Wm. G., So. Norwalk, Conn.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Mandrels, Solid
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Schellenbach & Darling Tool Co., Cincinnati, O.
Standard Tool Co., Cleveland, O.
Wells Bros. Co., Greenfield, Mass.

Marking Machines
Slate Machine Co., Dwight, Hartford, Conn.

Measuring Machines
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.

Mechanical Draft
Sturtevant Co., B. F., Hyde Park, Mass.

Burning a New Jaw on a Heavy Shear

The Use of Thermit for Heating the Fractured Surface to the Fusing Point before Pouring the Cast Iron

EDITORIAL CORRESPONDENCE

The breaking down of a heavy tool generally means much more than the mere cost of the casting or other broken portion, as the delay in securing new parts, the time taken to replace the old by the new, and general confusion materially reduce the output of that department.

An instance of unusual interest to all mechanics comes from the shops of the Raleigh Iron Works Company, Raleigh, N. C., in the successful repairing of the heavy shearing machine shown in the illustration. This machine has a capacity of 1½x6-inch bars, so that any repair must be of a very substantial nature.

A large corner of the lower jaw, weighing about 75 pounds, was broken off and it became a question of getting a new frame or burning on a corner; but the fusing of a surface about one square foot in area in order to secure a thorough union is not an easy matter, probably impossible by ordinary methods.

It was decided to try Thermit for this purpose, and a mold of core sand was made, thoroughly dried and baked. Before fastening into place, the surface of the break had been chipped to induce better fusion, as a fractured iron casting is usually glazed by graphite carbon.

The mold was securely fastened and well luted with fire clay, wherever there was any danger of leakage. As an extra precaution moist sand was rammed around the mold and its parts.

The surface of the fracture and the stock around the jaw were next heated with several gas jets through the gates and risers, to get the casting thoroughly heated, to drive out all moisture and burn away any oil that might interfere with the work. These gas torches were kept in operation several hours to be sure of sufficient heating.

A crucible carrying 175 pounds of Thermit and so arranged as to be tapped at the bottom was then placed over the pouring gate leading to the lowest part of the mold, which resembles a much jointed stove-pipe in the illustration.

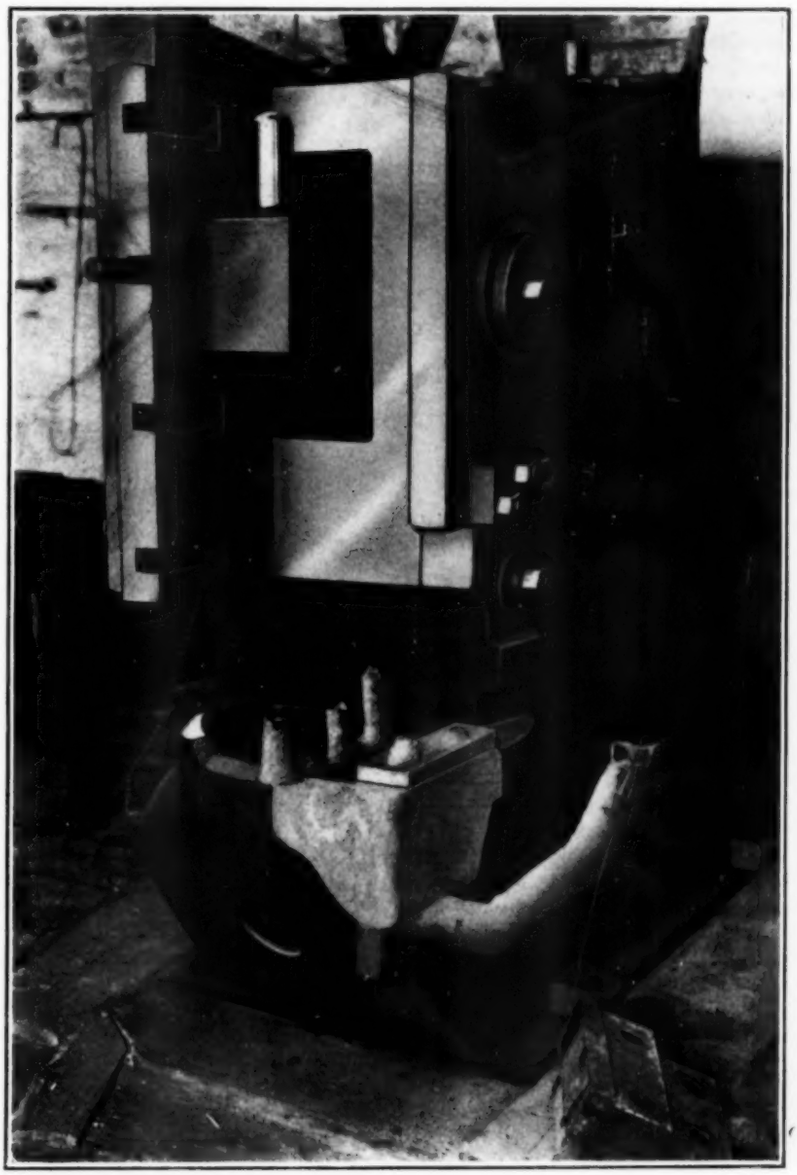
This was ignited with a teaspoonful of fuse powder on top, which was set off by touching it with the point of a red-hot poker.

In half a minute this had burnt down and produced in the reaction 88 pounds of mild steel at the very high temperature of 5400 degrees Fahrenheit. This was aided by the tapping of the crucible from the bottom, as the superheated steel filled the mold at once and fused the entire surface of the fracture.

In the meantime a ladle of molten cast iron containing about 600 pounds of metal was held in readiness and was also superheated by a semi-steel can. As soon as possible after pouring the Thermit, the cast iron was poured in the other gate, shown at the front of the jaw, and this forced the Thermit steel out of the mold after it had served its purpose by bringing the surface of the fracture to a welding or fusing heat, and the result was a new corner of the jaw, burnt on to the old as though it had always been there.

The illustration shows the two gates and four risers as they looked before any trimming-up had been done.

This work was done under the personal supervision of Wm. T. Harding, president of the company, who informs us that the shear is again in continuous operation and that there are no signs of any giving way of the lower jaw. Sections of the large gate and of the risers show how clearly the Thermit was washed from the mold and replaced by clean cast iron.



BURNING A NEW JAW ON A HEAVY SHEAR

Making Worms in a Molding Machine

By Robert Patten

The worm shown at Fig. 1 is one which is used on every loom of a certain make, and the proposition I ran up against was to reduce the price from $130 to $15 per thousand. It may be interesting to some of the readers to know how this was done and also how much the production was increased.

Having had a considerable experience in mounting different patterns on the Pridmore molding machine, I decided to produce these worms by special devices; the half-tones and sketches help to show how these were made. I made two right-hand worms and two left-hand worms at the same operation.

The worm as shown in Fig. 1 was double-thread, 6 pitch, the other dimensions being given.

Costs 12 Cents Each in Lathe

This worm runs in a cast worm wheel

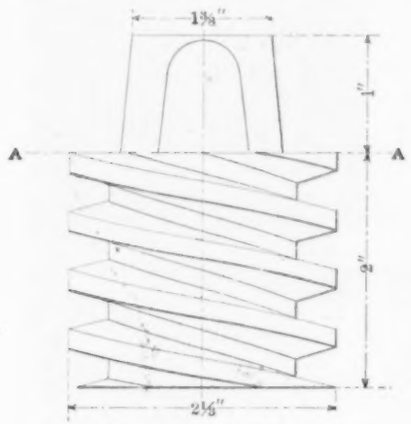


FIG. 1. THE WORM TO BE MADE

at fairly high speed; so it must be perfectly round, which could not be if it were made by a split pattern on plates, as the rap in drawing pattern and fin at parting lines does not make a perfect worm, although it can be used in some cases. These worms were formerly made in blanks, turned and cut in the lathe, costing 12 cents each after blanks were cast.

These four patterns, two right-hand and two left-hand, were placed about 6¼ inches apart to allow room to tuck the sand nicely around the worms. This is the most particular part for the molder, getting the sand tucked uniformly around the patterns to get a perfect casting, then the flask can be filled up and rammed as in an ordinary pattern.

Taking 6¼ inches from center to center of patterns, as in Fig. 2, I figured out the gearing required to revolve these four worms at once down through the stripping plate. So on the shaft from hand wheel *D'*, Fig. 3, I put two right-hand worms *D D*, quadruple thread, Fig. 3. On the four upright shafts *C*, which carried the patterns through the stripping plate, I put four worm wheels, as at *F*, Fig. 3. These were cut on straight angle, one on each upright shaft; these meshed into worms on the hand-wheel shaft *D'* Fig. 3, and gave me 6¼ inches between centers.

Molds Four Worms at Once

By turning the hand wheel to the right, the two worm wheels on the right side of shaft *D'* revolve to the left and the two worm wheels on the left revolve to the right. The case for these gears was made in two parts and bolted together with parting at *Pa*, Fig. 3. The four upright shafts that the patterns are on must be a good working fit in this worm wheel, and a spline is cut the full length of each shaft while a key is fitted tight in the worm wheels. The four bottom holes in

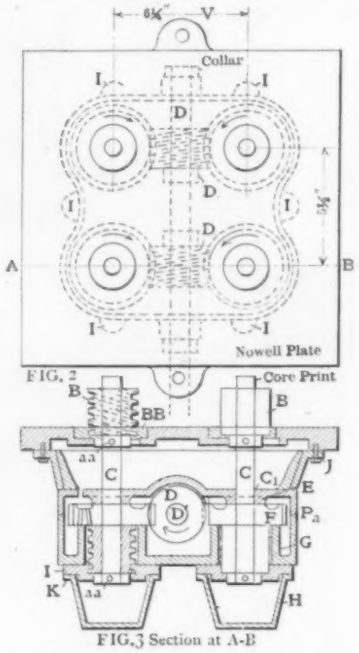


FIG. 3 Section at A-B

THE STRIPPING PLATE AND THE WORMS

this gear case, Fig. 3, are big enough to allow for the bottom worms to have plenty of clearance, and the upper edge of this hub *G*, Fig. 3, makes the bottom rest for these worm wheels. A hub *E* on the under side of the case holds these worm wheels in a fixed position, but allows them to revolve as the hand wheel is turned. The bronze nut *I* being fixed to the case, as soon as the upright shafts begin to revolve they must follow the lead in nut *I* and come down or up as the hand wheel is turned. To operate these patterns full length up and down, the space between the bottom of the stripping plate and the top of the case, and the depth of space in cup *H*, must be enough to allow these patterns *B B* to about come clear through the stripping plate when down, to allow the molder to brush out the fine sand which will work down with the pattern and if not brushed away will soon cause it to move hard.

Securing Equal Lead

These worms for patterns were made of a hard composition of brass, the blanks being made long enough so that after threading they were cut in two, taking one part for pattern *B*, and the other part for the worm on the bottom of the upright shaft to be sure they both had the same lead. These worms were long enough to allow enough of the thread to be in both the babbitt nut *B B* and the bronze nut *I* when it is at its full hight above the stripping plate.

In fitting these worms on to the upright shafts *C*, room was left in the top of the pattern for the core print to be fitted in. This stripping plate has four holes cored through large enough for the worm patterns to go through freely in the rough casting; it is also cored large enough on top to allow for a babbitt nut here for stripping worm, as at *B B*, Fig.

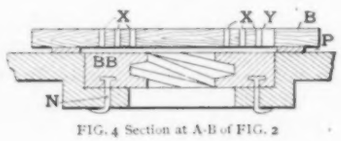


FIG. 4 Section at A-B of FIG. 2

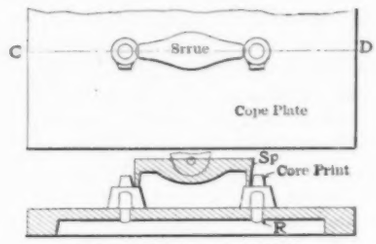


FIG. 5 Section of Cope Plate at C-D

CASTING THE BABBITT NUT AND POURING THE WORM

4. This plate was drilled in this cored pocket about every ¾ inch apart and a flat-head wire nail driven in, leaving about 3/16 of the nail above and the end bent over on the under side of the plate, as shown. I next cut four rings of pasteboard about 1/16 thick, the holes in these rings being a little larger than the cored pocket in the plate, Fig. 4, and laid around each of the four pockets. I then took four round pieces of wood larger than the pasteboard and drilled them full of small holes, as *X*, Fig. 4, putting them on the pasteboard rings, and set heavy weights on each. Then I moved the hand wheel of the machine until the four patterns came hard up against the wooden covers. I heated the plate good and hot after puttying up around the worms on the underside of the plate to keep the babbitt from leaking through, and poured these pockets with a good hard babbitt through the wooden covers at *Y*.

The perforated holes *X*, Fig. 4, allowed the air to escape as fast as babbitt was poured in and made a fine nut. The pasteboard rings allow enough babbitt to come above the surface of the plate to scrape off to a good surface.

Making A Working Fit

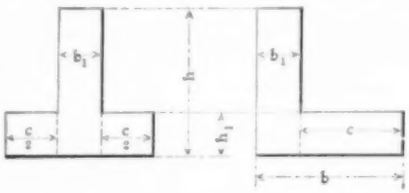
To make a good working fit in these babbitt nuts, two layers of toilet paper were first pasted around the threads of the worms, the babbitt flowing nicely around this. After the babbitt is cold, a little water around the worms will soak this to a pulp, when the worms can be removed by hand, and you have a nice working fit without any scraping of babbitt.

The leg for this machine is the regular one used for screwing cope plates to when it is not necessary to use a machine. This is made the right hight to work over conveniently. To make any other worm

A New Formula for Moment of Inertia

By Con Wise

The following formula for the moment of inertia of a tee or angle about its



DIMENSIONS USED IN FINDING MOMENT OF INERTIA

gravity axis looks more formidable than it really is. In fact it is the least uncomfortable one that I have seen; and since I have not run across it in print, I thought it would be a good thing to share with your readers.

To use it I set up a blank equation like this:

$$Ig = \frac{f+c}{3} - \frac{(e+b)^2}{4(d+a)}.$$

At *a* I fill in the product of $c \times h_1$;
b I fill in the product of $c \times h_1 \times h_1$;
c I fill in the product of $c \times h_1 \times h_1 \times h_1$;
d I fill in the product of $b_1 \times h$;
e I fill in the product of $b_1 \times h \times h$;
f I fill in the product of $b_1 \times h \times h \times h$.

These values can be successively taken off the slide rule with no more work than if only the values for *c* and *f* were to be found. After filling in these blanks in the equation the rest is simple.

For the benefit of those who like mathematics or for the benefit of anyone who would like to see if my figures are right, I add the way in which I arrived at this equation.

To get the distance of the center of gravity of the section from the base (taking moments about the bottom).

$$d = \frac{\frac{b_1 h^2}{2} + \frac{c h_1^2}{2}}{b_1 h + c h_1} = \frac{b_1 h^2 + c h_1^2}{2(b_1 h + c h_1)}.$$

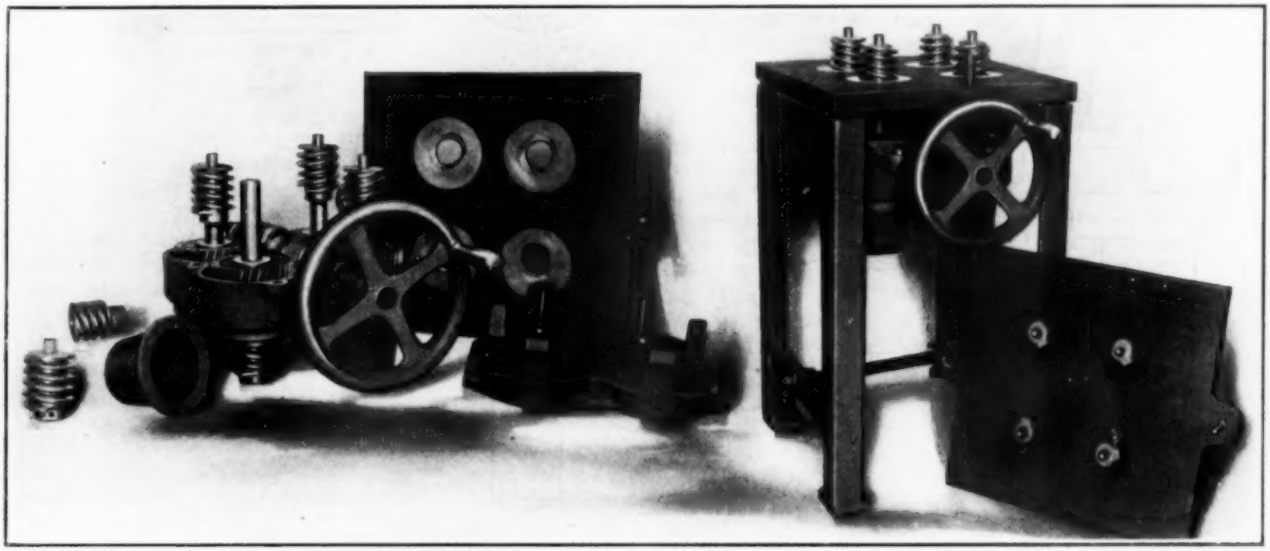
The moment of inertia for the web of hight *h* and width b_1 is its moment of inertia about its gravity axis plus the product of its area by the square of the distance between its gravity axis and the gravity axis of the figure as a whole; or,

$$\frac{I}{I} = \frac{b_1 h^3}{12} + b_1 h \left[\frac{h}{2} - d\right]^2.$$

For the flange, in the same way,

$$I = \frac{c h_1^3}{12} + c h_1 \left[d - \frac{h_1}{2}\right]^2.$$

These two added and reduced, after substituting in the value of *d* above, gives the equation desired. It will be noted that the numerical value of *d* can be fully as readily gotten from this expression for *d* as in any other of the ways usually given in text-books.



FIGS. 6 AND 7. THE MECHANISM FOR DRAWING THE WORMS

with this same mechanism it is necessary to remove the stripping plate, take patterns *B*, worm *B'* and bronze nut *I*, and in their places put on the worm required and a bronze nut to fit; then babbitt the new stripping plate.

These worms were made in a snap flask 13x13x3 inches deep and poured by a cup-shaped sprue on the end of the hubs, two sprues being used and two worms connected to each sprue, as at Fig. 5. This machine can produce 400 per day at about 1½ cents each, or nearly as cheap as the blanks are produced in the first case. The half-tones, Figs. 6 and 7, show the mechanism, and the whole machine. These cast-iron worms, having a hard scale, will outwear about three of the cut worms, besides leaving a lathe in the machine shop for other work.

The crank-pin of an engine travels 1.57 times as fast the piston.

The total deaths by accidents in mines in the United Kingdom in 1906 were 1133, as against 1159 in the previous year, being a decrease of 26. Under the Metalliferous Mines Act the total number of separate fatal accidents during the year amounted to 34, as against 43 in 1905, a decrease of nine. The deaths caused by these accidents numbered 37, as compared with 46 in 1905. Under the Quarries Act there were 92 separate fatal accidents during 1906, as against 97 in 1905; these accidents caused 97 deaths, as compared with 99 in the previous year.

It is reported that the United States Steel Corporation will soon begin the construction of a new steel plant at Duluth. The estimated cost of the plant is $10,000,000.

A Fixture Used in Pouring White-metal Bearings

A Device Carrying a Pair of Arbors and a Series of Collapsible Bushings around Which the Metal Bearings Are Run

BY CHARLES PRESCOTT FULLER

It is seldom that one sees, even in a modern workshop where every process is presumably up-to-date, a really common-sense system for running the journal boxes for machine shafts with what is variously known as babbitt, white, anti-friction, or composition metal. This job is done in the majority of shops in what may be termed a make-shift way, and it is a job that generally gets put into the hands of men who have sufficient knowledge of what is needed to accurately set the several shafts to true alinement with each other and the machine to which they are fitted. In many jobbing shops this lining up is done in rough and ready fashion, with level and square, though in other places micrometer and surface gages are employed, and in the hands of competent men the results if not perfect are fairly satisfactory.

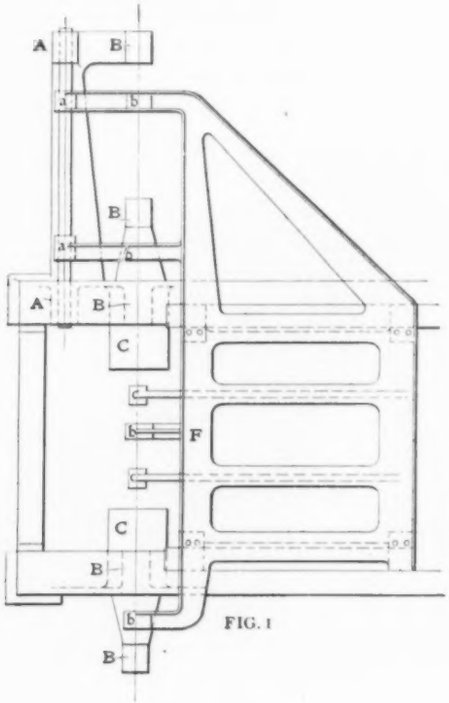


FIG. 1

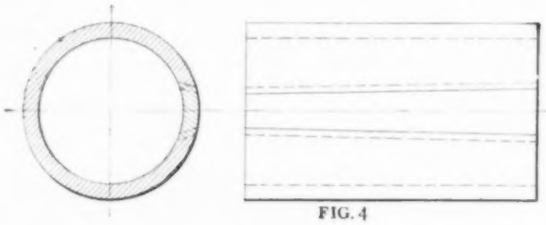


FIG. 4

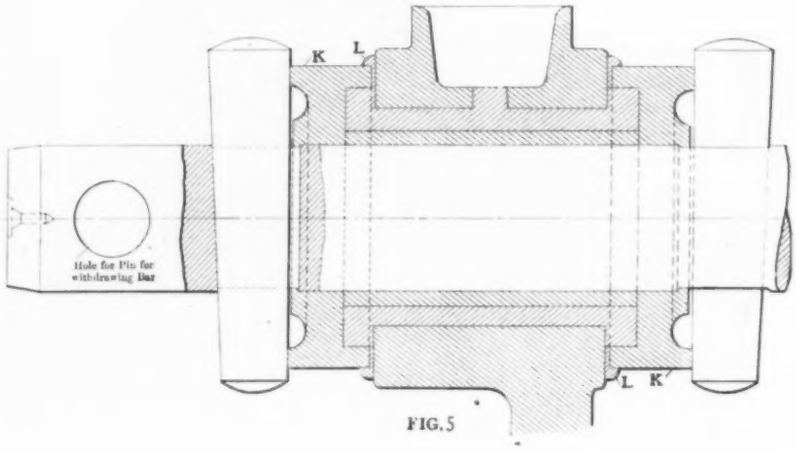


FIG. 5

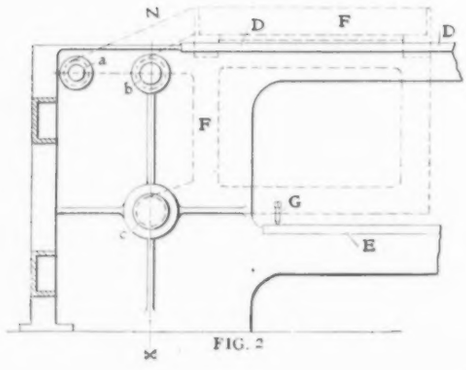


FIG. 2

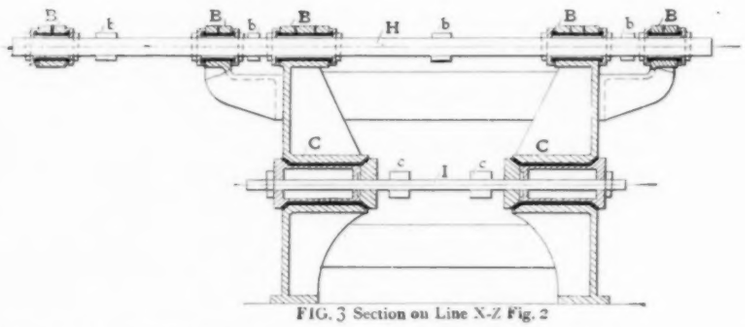


FIG. 3 Section on Line X-Z Fig. 2

THE MACHINE AND THE FIXTURE

A Messy Job

As a rule, too, the pouring of such bearings is done in the nastiest possible manner, with red lead, putty, clay, alabaster, etc., placed to keep the metal from running loose; and these ingredients often need old bits of rag, or sacking, tied on with twine to keep them in place. In fact the whole job is a messy one. Also the removal of journal caps or mandrels from solid journals is generally accompanied by much burning of fingers and presumably cooling (?) language. There are any amount of mandrel dodges used on this class of work, the majority of which doubtless are familiar to most shop men; so that little need be said about them, except that they are generally faddy and quite apt to stick just when they should be easy.

Babbitting Jigs Should Be Used

All this messing and muddling is easily avoidable, and the majority of such jobs for new machinery should be handled with a fixture or jig whereby an unskilled laborer or apprentice lad may do the whole thing from start to finish, with no need of setting and alining, or following any of the kinks usually necessary; and when done the job will be practically perfect, thus leaving the skilled man free to do work more worthy of his knowledge and skill than pouring metal out of a ladle into a hole.

As an illustration of the use of a jig for running white-metal bearings, the accompanying sketches and following description of an actual job, jig, and procedure may prove of interest as they will possibly indicate how very similar arrangements can be made in connection with many machines in daily course of construction, and any amount of time and expense in workshops saved.

The Machine and the Jig

Fig. 1 is a plan of one end of the machine with the jig in place; Fig. 2 is a longitudinal section of the end of the machine, the jig being shown here in dotted lines; Fig. 3 is a vertical section through *X-Z*, Fig. 2. Fig. 4 is an enlarged view of a collapsible bush, and Fig. 5 is an enlarged view of the journal box poured with white metal.

The two bearings *A A* were for a fixed shaft on the machine, which, while fitting at each end in bored holes, did not revolve. The five bearings *B B* were all 2½ inches diameter and all in one line, and were made to carry a shaft revolving at about 350 turns per minute, transmitting motion to gears carried below in the bearings *C C*, which were 4 inches diameter and about 12 inches in length, the gears making 60 turns per minute. The shaft carried in the five bearings *B* received its power from a peculiar differential set of driving pulleys and gearing running upon the shaft carried by the bearings *A A*, at about 600 turns per minute and absorbing here five indicated horse-power. *D* and *E* were upper and lower planed ways upon the machine frames, and it was absolutely necessary not only that all the shafts should be parallel to each other, but also that they should be exactly 90 degrees both ways with *D* and *E*.

Former Difficulties

For simplicity it was decided to utilize white-metal bearings for this machine, and at the commencement the old putty-puddle, mud-fire style of running up was resorted to, causing much waste of time and temper, and a very poor job. As a rule, the five bearings in line gave no end of trouble in scraping to a running fit, and later it was found that the white metal became loose in the cored holes in the frames and brackets, often necessitating repouring of the bearings, which again, meant much loss of time and temper, to say nothing of the expense involved thereby. The users of the machines were dissatisfied, and the machines themselves showed their protest by occasionally smashing the train of gearing, and in other ways at most inconvenient moments; and it was thought that it would be necessary to revert to some form of separate bearings bolted to the machine.

Alterations Considered

Now this not only meant serious alteration to existing and expensive cast-iron patterns for the sides of the machine, which weighed a ton each, but it had been proved by previous experience that separately fixed bearings, even when planed and juggled in, on a similar machine were a nuisance and broke loose, and it would have meant a very special and costly job to avoid this; and as the run-up bearings when they did happen to be just right, by some stroke of luck, or extra care, or other unknown quantity, had proved exactly what was needed to make the machine work well and easily, it was decided to think again and try to overcome the several troubles that occurred. The engineer who had designed the machine was asked to get over the difficulty, which he did in the following manner:

The models, by the way, were as nearly perfect as careful workmanship could make them; the machining of the various parts was also done in such a manner that it was practically an impossibility to get any cross wind into the surfaces *D* and *E* in any direction, when the framework was securely bolted together. The holes for the fixed shaft in *A A* being bored from the planed surface of the one side before bolting up, under a radial-arm boring machine, were also at right angles to it.

Construction of the Jig

The frame jig *F* was designed and machined so that it took a bearing on top and between the planed edges of *D D*. Set screws *G G* were arranged at the lower part of the jig to swing into position, and just take a bearing on *E E* as a support only, these being lightly set down with finger and thumb till they touched the surfaces, after the jig had been firmly clamped to the upper planed surfaces at *D D*. From the jig body arms were carried out, these being cast in place, each arm having bosses to coincide with the bearing boxes to be run with white metal. These arms carried bosses *aa*, *bbbb*, and *cc*. The bosses *a a*, were bored and lapped a sliding fit for the fixed shaft secured in *A A*, and this shaft when slid into place through its bosses gave a definite position for the whole jig, which being held thereby and on and between the planed surfaces *D D* could not possibly be set anyway except correctly.

Accuracy Assured

The other holes in the jig bosses were likewise bored and lapped a sliding fit for the jig shafts, all being bored and lapped at one setting from the seats planed to rest on the frame surfaces *D D*, to render certain the truth of all the jig holes. A complete train of gearing was made from the gear models, and these were bored to accurately fit the jig shafts and run round by hand thereon, thereby making sure that the centers were correct, and these gears were put aside for use in making other jigs in the event of the original one being broken. As has been said, all holes were lead lapped in the jig to a sliding fit, a necessity in such apparatus if quick work is to be done. The jig shafts *H* and *I* were made of hard-rolled steel, and turned roughly within 1/32 of finished size. The cotter holes, shown in Fig. 5, were then marked off, drilled and slotted in the shafts, and the latter were then put in the lathe, straightened and turned nearly to finished size, after which they were ground on dead centers and polished so as to slide nicely in their holes in the jig bosses, the diameter of the shaft for bosses *b b* being 23/16 inches.

The Mandrel Shells

To fit over the shaft *H*, six steel shells, Fig. 4, were bored and lapped to an easy push fit, each being cut to the exact length of the journal box for which it was to be used as a mandrel in pourng the metal. These six shells were then rough turned on a mandrel, after which from five of them were planed out wedge-shaped strips undercut or dovetailed as shown in the detail. These strips were cut out with the shells fixed on a slotted mandrel, to secure a clean finished cut, the mandrel being held in a center fixture and set over each way to a stop, so that the openings cut were all alike. The shells were held up at each side with V-blocks to avoid outward spring as the tool took its last cuts through the wall of metal. Then from the sixth shell were cut six strips of exactly the same shape and size as the openings in the other five, and the edges of the openings in the shells of the strips were then carefully scraped off and each shell in turn placed on a mandrel, and one of the strips secured in place with very soft brazing material.

Finishing the Shells

The shells were then turned within a fraction of the finished size, the ends of the wedges trimmed flush, and the shells then finished on dead centers in the grinding machine and by lapping. When finished, they were 0.020 inch larger than the shafts that were to run in the bearings, this extra size allowing for contraction of the white metal in cooling and for a running fit for the shaft. The shells were then placed in a gas-heated muffle, being well plugged with clay and heated outside

until the brazing ran and the wedge strips fell out. When cleaned they were ready for use. These were the collapsible mandrels for running the *B* bearings shown in Fig. 3. Those for the bearings *C C* were constructed differently, owing to the special 45-degree resisting shoulders; they were of cast iron, hard and close, and the wedge strips had removable heads outside attached by means of screws. The general preparation of these mandrels was similar to that for those used for the bearings *B B*.

End Collars and Rings

To make white-metal bushings a success and prevent them from getting loose, it is necessary to form collars of the metal at each end of the journal box, always supposing them not to be tinned, which is no end of a nuisance. For this purpose hollow-ring collars were made to fit each end of the bearing to be, and between their faced edges and the casting an asbestos ring was placed. When the bearing was ready for pouring, it was as shown in the section Fig 5, *K* being the collars and *L* the asbestos rings.

Setting the Apparatus

To use this rig the jig *F* was placed in position, and, as has been said, it was impossible to locate it wrongly; the shaft *H* was put in at one end, and, each in its proper turn, the collapsible mandrels or shells, collar rings, and asbestos-packing rings were put on; the wedge strips for the mandrels were carefully pushed home to exact position and each complete set, consisting of collapsible mandrel, two rings and packing, was wedged up tightly by means of cotters through the slotted jig bar, a hide-faced hammer being used to prevent damage. The same course was taken with shaft *I* for bearings *C C*. The whole job of placing the tackle occupied but a few minutes, during which time the metal had been melting in a bunsen gas stove. The pouring in of the metal took but from five to ten minutes, being done from two sides at once.

Removing the Shafts and Shells

As soon as the metal was set the cotters were removed, the steel jig shaft drawn out by hand before it had time to heat up, the conical strips were knocked out with a bronze drift, and the collapsible shells similarly removed; they didn't stick, as they shrunk slightly inward. The lower mandrels were treated similarly, and the job was done. When cool it was as nearly perfect as mechanical ingenuity could make it. The working shafts slid through the five bearings in a line, with never a touch of file or scraper, and when put under test and run to double their working speed never even warmed up.

The Time Required

It should be stated that the cored holes to receive the white metal were, previous to putting the whole rig in place, warmed up till they stopped sweating. The job, including warming up, putting the jig in place and all preparation, running in of metal and removing the tackle, leaving the job finished, took about ¾ of an hour, the warming up taking the most time. This had to be done carefully, the apparatus consisting of bunsen blow pipes with a ¾-inch opening, operated by two lads. The jig was lifted in and out by a light, overhead crane, and when out of use was hung up out of harm's way on a column.

A Comparison of Methods

The cost was figured up as follows: Had the machine been fitted with specially designed plummer block type of bearings, these would have had to be planed, bored, drilled, bolted and fitted, and furnished with metal liners, and each would have had at least four bolts or studs with nuts, and when in place would have to be scraped and humored and fooled with; had the holes been cored in solid frames and loose bushes afterward driven in, not only would the latter have to be bored and turned, but the driving in would have caused distortion and no end of trouble; and to bore the side frame holes, or the whole together to get good alinement, it would have been necessary to have a floor boring machine capable of dealing with the whole frame and brackets bolted together, which measured 12 feet x 8 feet x 3 feet 6 inches.

A Difficult Job Avoided

Such a job would not go comfortably on a light make-shift tool—to say nothing of handling three tons to and fro and around—and when done, what about those five holes in a line for a shaft making 350 revolutions per minute?

We all know well enough what it is to get three holes bored accurately in alinement, let alone five; and they always require some touching up, a scrape here and a scrap there, just to give the skilled man a chance, whose privilege it is to curse the draftsman a little for putting those three holes in line. Working out the cost like this and adding interest on the big boring machine necessary, and considering its first cost, it was found that the rig described for running bearings of white metal would itself cost but little more than the boring and fitting on half a dozen machines for these bearings alone.

Highly Satisfactory Results

The adoption of the jig was fully justified by the results obtained by its use, for some of these machines ran for 10 years on a 60-hour week with no perceptible wear, and may possibly be running now. The purchasers of the machines were so impressed with the capabilities of this rig that they bought a complete outfit in case of needful repairs; but it certainly had not been put to use within the period named, the necessity not having arisen.

The White Metal Used

The only trouble—and there is no avoiding trouble in anything in this world worth having—that occurred in connection with this job was in obtaining a composition white metal, which at that time could be guaranteed to give exactly the same results from different consignments; the composition was variable, which meant different contractions. Practically every metal that could be purchased was given a trial, and only one—the original magnolia brand—fulfilled the conditions, and this had the additional and very much to be desired quality of melting at a low heat and having no scum or dross, every particle being usable. It was confoundedly expensive then, but gave no failures in pouring, and the bearings never heated even under the great strain to which they were subjected when the machine was running. There is no doubt but that much of the success in the job was due to the unvarying quality of the metal used. Anyone who will give this system of running white-metal bearings with similar jigs a trial will be gratified with the results obtained; it is necessary, of course, to watch the amount of contraction that the particular brand of metal used may have, and then allow sufficient to meet this on the mandrel shells.

Care of the Jig

Needless to say, perhaps, the whole rig, of whatever form, must be finished with care and all surfaces be perfectly smooth. Care with the jig and accessories in use and while handling must be exercised, for if knocked about with screw keys for hammers and flung down like so much old junk in any corner, and piled over with scrap and castings, the shafts will soon be sprung and the whole rig generally go on strike. In the case referred to these things were looked to, and the shafts kept true all the time; and it was never necessary to renew them, although used many dozens of time.

Russia.

El Imparcial, of Mexico City, states that a syndicate has been formed to construct a railway between Mexico and Belize, Honduras, passing through the States of Yucatan, Campeche, Tabasco, and Vera Cruz, at a cost of $60,000,000 silver ($30,000,000 gold).

Consul M. J. Hendrick reports that the Belleville Portland Cement Company (Limited), of Belleville, Ontario, Canada, which now has a capacity of 900 barrels daily, will increase its capacity this summer to 2000 barrels per day, and is now in the market for the purchase of machinery and structural steel.

The Pressure on Tools When Cutting Steel*

Important Experiments Giving Practical Data for the Design of Machine Tools of All Classes Using Single-pointed Tools

BY FRED W. TAYLOR

The following are the general conclusions arrived at on this subject:

(A) The total pressure of the chip on the tool in cutting steel of the different qualities experimented upon by us varies between the low limit of 92 tons (2000 pounds) per square inch of sectional area of the chip, and the high limit of 168 tons (2000 pounds) per square inch sectional area of the chip.

(B) In cutting the same piece of steel, the pressure of the chip on the tool per square inch of sectional area of the chip grows very slightly greater as the chip becomes thinner, and is practically the same whether the cut is deep or shallow. See the accompanying table, from which are taken the following typical cases illustrating the relative pressures of a thin feed on the one hand and a coarse feed on the other.

Depth of cut 3/16 inch × feed 0.0156 inch: Total pressure per square inch sectional area of chip, 295,000. Depth of cut 3/16 inch × feed 0.125 inch: Total pressure per square inch sectional area of chip 257,000.

(C) The same fact mathematically expressed is that in cutting the same piece of steel, the pressure of the chip on the tool per square inch of sectional area of the chip grows greater as the thickness of the chip grows less in proportion to (thickness of the feed) $^{1}/_{4}$ or $F^{1}/_{4}$.

The pressure of the chip is in direct proportion to the depth of the cut.

(D) Within the limits of cutting speed in common use, the pressure of the chip upon the tool is the same whether fast or slow cutting speeds are used.

(E) The pressure of the chip upon the tool depends but little upon the hardness or softness of the steel being cut, but increases as the quality of the steel grows finer. In other words, high grades of steel, whether soft or hard, give greater pressures on the tool than are given by inferior qualities of steel.

(F) The pressure of the chip on the tool per square inch of sectional area of the chip depends both upon the tensile strength of the steel and its percentage of stretch, and increases both as the tensile strength and stretch increase; although a higher tensile strength has more effect than a large percentage of stretch in increasing the pressure.

*Extract from the presidential address before the American Society of Mechanical Engineers on the Art of Cutting Metals.

Pressure of Chip on Tool the Same Whether Fast or Slow Cutting Speeds Are Used

In the accompanying table, will be noted two sets of pressure experiments made upon steel of the same quality and with tools of the same shape, one set with cutting speeds of 30 feet per minute and another set with cutting speeds of 60 feet per minute. An inspection of the corresponding figures in these two sets of experiments and an examination of Figs. 1 and 2, in which the same data are shown graphically, will indicate that, in general, doubling the cutting speed has no appreciable effect upon the pressure on the tool.

This is in substantial agreement with the results obtained in the Manchester experiments. Dr. Nicolson, in one set of dynamometer experiments, made with the same tool and the same piece of steel, obtained increasingly lower pressures on the tool for increases in the cutting speed.

Owing to the voluminous nature of this paper, we shall not treat of the important subject of drilling or boring metals. We would, however, refer to a very elaborate and careful series of experiments by M. Codron, published in "Bulletin de La Société D'Encouragement pour L'Industrie Nationale, 1903," probably the most elaborate series of experiments on drilling, boring and trepanning that have yet been published. M. Codron's experiments cover the pressures required to cut not only steels of various hardnesses, but also cast iron, bronze and other metals, and are made on almost all points with the thoroughness characterizing the work of all of our best modern French scientists.

Power Required to Feed the Tool

By far the most important conclusion arrived at by us in the field of "Pressure of the Chip on the Tool" is that the gearing designed in lathes, boring mills, etc., for feeding the tool should be sufficiently strong to deliver at the nose of the tool a feeding pressure equal to the entire driving pressure of the chip upon the lip surface of the tool. This fact was developed by us in an experiment made in the year 1883 in the works of the Midvale Steel Company, and had such an important bearing upon the cost of turning out the product in the machine shop of those works that the results of this one simple investigation more than paid for all the experiments in the entire field of cutting metals undertaken in the Midvale Steel Works.

All of the lathes, boring mills, etc., purchased by this company from that time forward were fitted with feed gearing designed with power equal to the driving power of the machine, and in this way the many stoppages and delays so common in the average machine shop, due to broken feed gearing, were avoided. What is of even much greater importance, a lack of strength in the feed gearing never was accepted as an excuse on the part of any machinist for not taking the maximum cut on his machine.

Apparatus for Determining the Power Required to Feed a Tool

The following very simple apparatus was used in 1883 in our experiments upon the power required to feed the tool. In Fig. 6 will be seen a view of the vertical slide of a William Sellers & Co. 84-inch diameter vertical boring mill. Upon the top surface of this vertical slide a wooden lever was made to bear upon a knife edge, the short end of the lever being held down by a chain connected with an I-bolt, and at the long end of the lever a receptacle was suspended into which weights were added until the required feeding force was obtained. The vertical slide was at first fed by means of its usual feeding screw. A loose washer, however, was fitted beneath the nut of this screw, and this was, of course, kept tight while the operation of feeding was performed with the regular feed gearing, and weights were added on the end of the wooden lever until the feeding was done by means of the lever instead of by the regular feed mechanism. The point at which this transfer of the feed took place was determined by finding when the washer just became loose. This was found to be quite a sensitive indication of the power required to feed.

The experiments were made upon a locomotive tire, the metal of which was about carbon 0.56 per cent., manganese 0.68 per cent., tensile strength 124,000 pounds, and 12 per cent. to 14 per cent. of stretch.

Tools with cutting edges varying from a straight edge at right angles to the direction of the feed to our standard round-nosed tools were used, with a depth of cut varying from 1/16 inch to ¼ inch, and the thickness of the feed varying from 0.0243 inch to 0.0774 inch. The pressure required to feed a square-nosed tool was somewhat lighter than that required to feed our standard round-nosed tool, and under average conditions as to

DEPTH OF CUT IN INCHES	½" TOOL CUTTING SPEED ABOUT 60′ PER MINUTE SEE FIG. 3				¾" TOOL CUTTING SPEED ABOUT 30′ PER MINUTE SEE FIG. 1				¾" TOOL CUTTING SPEED ABOUT 60′ PER MINUTE SEE FIG. 2				1¼" TOOL CUTTING SPEED ABOUT 30′ PER MINUTE SEE FIG. 4				PRESSURE IN POUNDS, FIGURED BY FORMULA—230,000 $DF^{\frac{11}{10}}$ COMPARE THESE PRESSURES WITH THE EXPERIMENTAL PRESSURES IN THE OTHER FOUR COLUMNS OF THIS TABLE			
	EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS		EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS		EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS		EXPERIMENT NUMBER	FEED IN INCHES	PRESSURE IN POUNDS		FEED IN		PRESSURE IN POUNDS	
			ON TOOL	PER SQ. IN.			ON TOOL	PER SQ. IN.			ON TOOL	PER SQ. IN.			ON TOOL	PER SQ. IN.	FRACTIONS	DECIMALS	ON TOOL	PER SQ. IN
1/8	565	0.0154	586	304000					435	0.0144	605	336000	541	0.0186	709	306000	1/64	0.01562	593	303550
	566	0.0305	1040	273000					434	0.0281	907	258000	542	0.0296	1124	304000	1/32	0.03125	1132	289842
	567	0.0422	1730	328000	535	0.0460	1537	267000	433	0.0428	1286	240000	543	0.0448	1615	288000	3/64	0.04687	1653	282054
	568	0.0625	2120	271000					432	0.0606	1928	254000	544	0.0608	1930	253000	1/16	0.06250	2162	276754
	569	0.0909	2850	250000	534	0.0909	3230	284000	431	0.0888	3175	286000	545	0.0930	3230	278000	3/32	0.09375	3156	269314
					534½	0.1282	4138	256000	430	0.1275	3855	242000	546	0.1250	4510	288000	⅛	0.12500	4129	264256
3/16	570	0.0166	993	319000					415	0.0115	736	341000	552	0.0156	865	295000	1/64	0.01562	889	303550
	571	0.0275	1400	271000	523	0.0314	1542	262000	414	0.0280	1345	256000	551	0.0300	1496	266000	1/32	0.03125	1698	289842
	572	0.0420	2690	341000					413	0.0414	2238	288000	550	0.0440	1986	241000	3/64	0.04687	2479	282054
	573	0.0625	3100	265000	520	0.0625	2721	232000	412	0.0625	3020	258000	549	0.0632	2760	237000	1/16	0.06250	3243	276754
					521	0 0385	4150	250000	416	0 0882	4884	295000	548	0.0909	4600	270000	3/32	0.09375	4734	269314
					522 539	0.0125	6620 5700	282000 243000	538	0.1250	5160	220000	547	0.1250	6000	257000	⅛	0.12500	6194	264256
9/32	574	0.0148	1300	342000					429	0.0140	1184	301000	553	0.0148	1230	296000	1/64	0.01562	1334	303550
	575	0.0275	2100	272000	530	0.0310	2230	255000	428	0.0287	2405	298000	554	0.0286	2135	265000	1/32	0 03125	2547	289842
					531	0.0452	3520	277000	427	0.0423	3320	278000	555	0.0403	2790	246000	3/64	0 04687	3718	282054
					532	0.0606	4430	239000	426	0.0620	4680	268000	556	0.0645	4630	255000	1/16	0.06250	4865	276754
					533	0.0909	7050	275000	425	0.0909	6708	262000	557	0.0909	6680	248000	3/32	0.09375	7101	269314
27/64	577	0.0148	2130	341000					424	0.0150	1932	305000	558	0.0174	2090	285000	1/64	0.01562	2001	303550
					529	0.0300	3680	290000	423	0.0298	3665	291000	559	0.0285	3360	279000	1/32	0.03125	3821	289842
					527	0.0448	5460	238000	422	0.0427	4930	273000	560	0.0405	4640	271000	3/64	0.04687	5578	282054
					528	0.0625	6920	262000	421	0.0552	6200	266000	561 576	0.0606	5760 6730	225000 263000	1/16	0.06250	7297	276754
81/128					525	0.0182	4270	371000					562	0.0154	2980	305000	1/64	0.01562	3001	303550
					524	0.0306	6140	317000					563	0.0282	5760	327000	1/32	0.03125	5732	289842
					526	0.0415	7815	297000	420	0.0424	7776	289000	564	0.0400	7700	304000	3/64	0.04687	8367	283054

PRESSURE ON TOOL WHEN CUTTING STEEL WITH STANDARD ROUND-NOSE ROUGHING TOOLS HAVING A CLEARANCE ANGLE OF 6, BACKSLOPE OF 8 AND SIDE SLOPE OF 14 DEGREES

the dullness of the tool, after eliminating the friction of the slide to which the tool was attached, the pressure upon the lip surface of the tool was found to be about 2.2 times the power required to feed the tool.

It should be noted, however, that the words "tool of average dullness" have a different meaning in our case from the same term as applied to tools in the average machine shop, since it was our regular practice to use tools much duller on the average than those in common use in other shops. We ran at such relatively high cutting speeds that the cutting edges of our tools were soon rounded over, and this undoubtedly produced higher feeding pressures than would be required for the ordinary sharp lathe tool.

However, before finishing our experiments it occurred to us that the normal power required to feed the tool was not the figure which should be used in designing machine tools, but that the maximum power which would ever be likely to be called for in feeding the tool was the only one to be used practically. This led to an experiment in which an exceedingly dull tool was used, such a tool as would only be allowed by a very careless machinist to continue under cut, but which condition was sooner or later sure to arise in the case of every machine tool throughout the shop.

The use just once of a scandalously dull tool in a machine would, of course, suffice to smash the feed gearing. An experiment made with a tool of this kind demonstrated the fact that to insure against breakage sufficient strength was called for in the feed gears to deliver at the nose of the tool a pressure equal to the total driving pressure of the chip upon the tool.

This one almost brutal experiment rendered all our more careful and accurate experiments of merely trifling interest.

When in 1904, the thoroughly scientific work of Dr. Nicolson in this field with his lathe-tool dynamometer was published, it was with no little interest that we read his paper, feeling that in the end he was doomed to the same disappointment as to much of the scientific value of his work as we had experienced from ours. Un

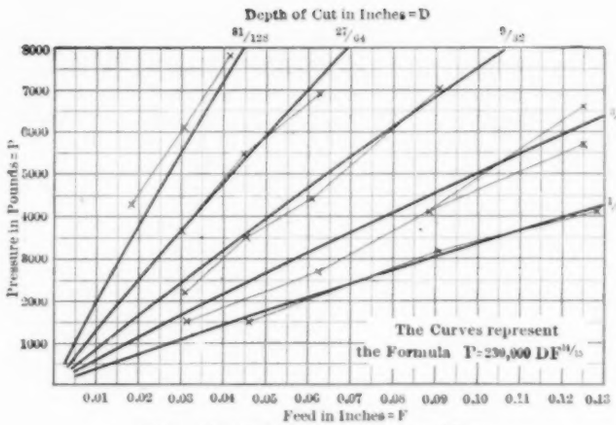


FIG. 1 Cutting Speed about 30 Feet per Minute

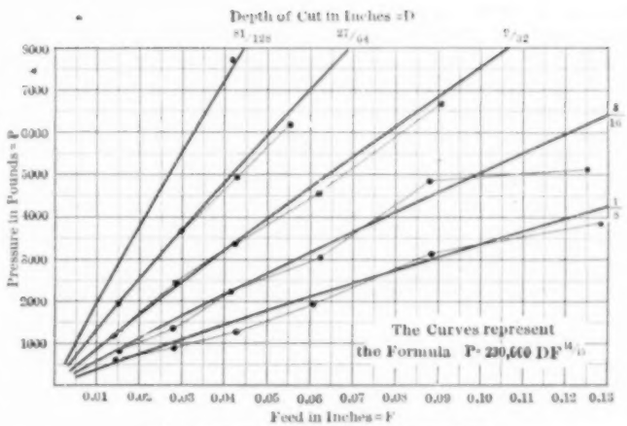


FIG. 2 Cutting Speed about 60 Feet per Minute

COMPARATIVE EXPERIMENTS AT DIFFERENT SPEEDS

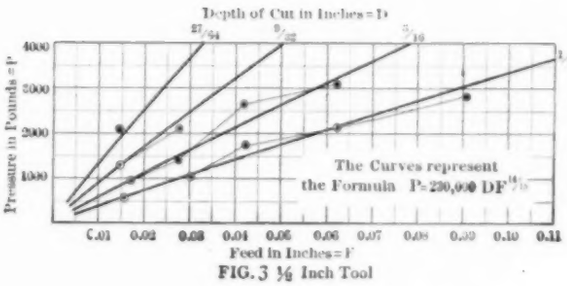


FIG. 3 ⅛ Inch Tool

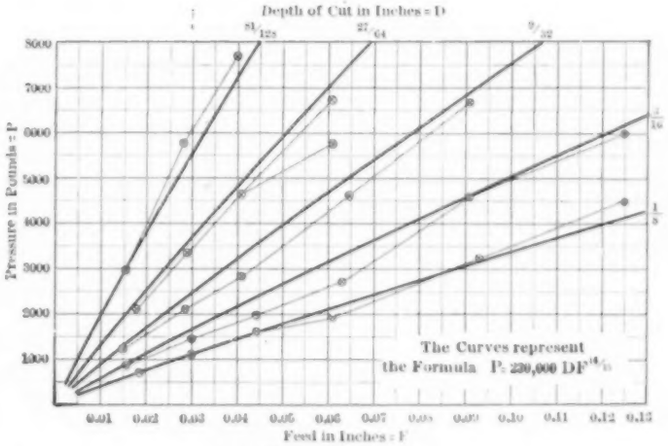


FIG. 4 ¼ Inch Tool

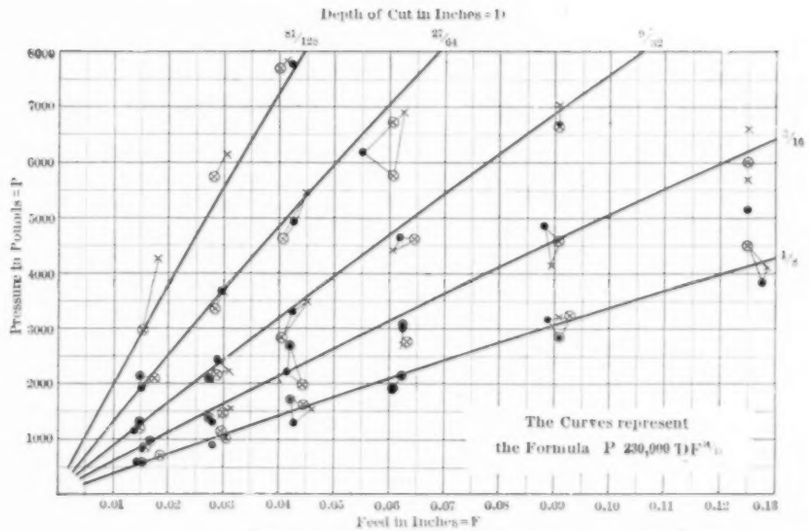


FIG. 5. Summary of Experiments.

The following Notation is also used in Figs. 1, 2, 3 & 4.

- ⊙ = ⅛" tool, Cutting Speed 60' per minute.
- ● = ⅜" tool, Cutting Speed 60' per minute.
- × = ¾" tool, Cutting Speed 30' per minute.
- ⊕ = 1¾" tool, Cutting Speed 30' per minute.

CHEMICAL COMPOSITION

Carbon	0.54
Manganese	0.54
Silicon	0.176
Phosphorus	0.037
Sulphur	0.026

PHYSICAL PROPERTIES

Tensile Strength	70280
Elastic Limit	33613
Elongation	23.00
Contraction	25.08

Annealed at 1500°

TAYLOR'S EXPERIMENTS ON THE PRESSURE OF THE CHIP ON THE TOOL IN CUTTING STEEL WITH STANDARD ½-, ¾- AND 1¼-INCH ROUND-NOSE ROUGHING TOOLS, HAVING A CLEARANCE ANGLE OF 6, BACK SLOPE OF 8 AND SIDE SLOPE OF 14 DEGREES

fortunately, however, Dr. Nicolson's experiments were not extended to a scandalously dull tool, and for that reason readers of his paper must be warned against the adoption in tool design of the figures on feeding (or "traversing")

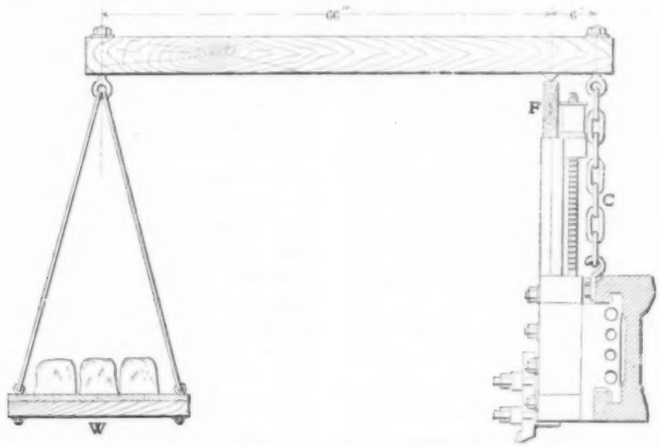


FIG. 6. APPARATUS USED IN EXPERIMENTS FOR MEASURING THE PRESSURE REQUIRED TO FEED A TOOL

pressure obtained by him. We do not, of course, state that the data in Dr. Nicolson's paper were not of great scientific interest, but merely that for the one perhaps most important purpose for which the experiments were undertaken his data should be disregarded.

Shop Tools and Methods

By F. J. Le Card

Along the line of bench-lathe work and appliances, Fig. 1 represents a device that is considered indispensable in the shop where I work at present.

It is intended to force a stream of oil through the running-lathe spindle and chuck, to wash back from a drill or other tool the chips which otherwise enter the slots in a spring chuck and make endless trouble. In the shop referred to, as in many others, oil is supplied to all the machines requiring it by means of a tank and pump, with carrying pipes, etc. *A* is a piece of ordinary gas pipe with connection as shown, the arrow indicating the direction of the oil flow. *B* is a chambered joint in which the tube *C* runs freely, it having some movement endways to admit loosening the chuck draw in spindle. There are four inlets for the oil at *D*, and a plug at *E* closes the outer end of the tube. The tube *C* is a holding fit in the draw in spindle and turns with it while *B* is stationary; but very little oil escapes into the drip pan. The pressure of the oil can be regulated by the cock on the feed pipe. The oil not only removes the chips, but pushes the work out when the chuck is loosened.

A Slotting Chuck

Fig. 2 is a cheap tool or chuck for holding pieces, as shown, for slotting them or making a variety of possible cuts on short work. A piece of round stock *F* is milled open at the top, leaving enough of the circle about the center hole to allow the work to be secured with a set screw from underneath.

Making a Slender Arbor

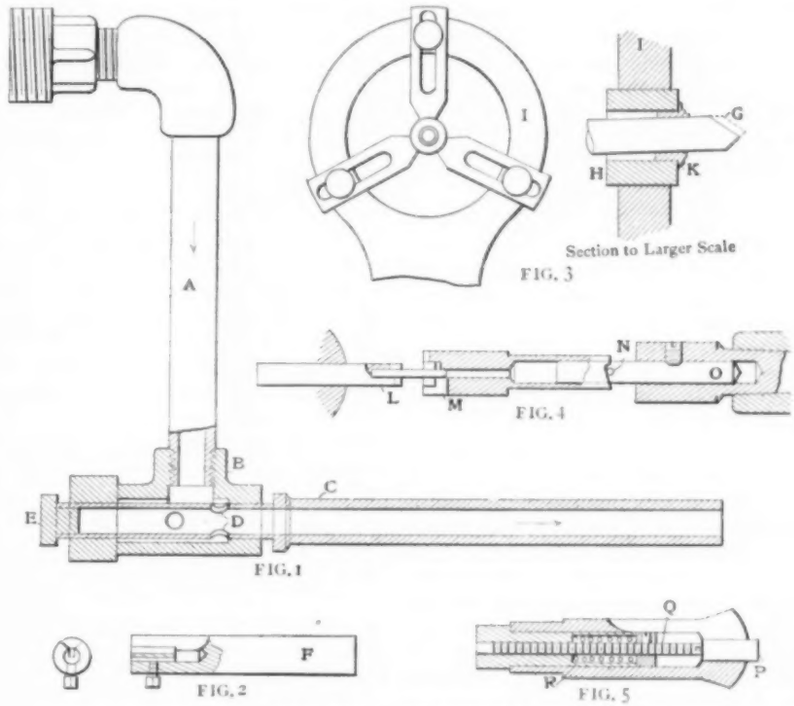
Fig. 3 partially explains one method of making a long, slender, spring-tempered arbor. Suppose it is required to make an arbor 2x⅛ inches extending from any kind of a shank. Leave about 1/32 for turning true when tempered. A good temper for steel that will cut readily and will not spring, or rather set, is a color past a sky blue, nearing a brick tint.

But first, before tempering, see how much it has been distorted by hardening. It may run out 1/16 of an inch; then heat it red again and let it cool slowly. Then straighten and reharden until it comes true enough to use; which it generally does at one or two trials. If it is intended to grind the arbor true, the center can be found by steadying the end, while running, by a notched piece of wood held in the hand while the emery wheel touches the point.

For getting the center, as indicated in Fig. 3, where the arbor runs out at the point as shown by the dotted lines at *G*, a collar *H* is put centrally in the steady rest *I*, the hole in the collar to be large enough to clear the arbor. Then, while the arbor stands at rest, float solder, as at *K*, against it and the collar *H* by means of a very hot soldering copper. Hold the latter against this collar so as not to move the arbor. Then turn off the point of *G*, as seen, to run in the female center. By using a diamond-point tool of, say, Styrian steel with temper omitted, and point fine in shape, the work can be easily and very smoothly turned. Afterward it is stoned or filed and lapped.

A Relieving Device

Fig. 4 shows a way of backing off end tools or cutters of different shapes. This works well when the diameter of the cutting circle is not too small. In this illustration just a plain tool is shown without fancy outlines. *L* is a counterbore used for forming the shape in tool *M* and also for backing it off. The latter has a hollow shank, and two opposite bevels, or cam surfaces, are filed on the end to work over the pin *N* passing through the guide rod *O*. This rod is held securely in the tailstock spindle. Tool *L* is held stationary in its chuck and tool *M*, to be operated



SHOP TOOLS AND METHODS

upon, is held by a dog or drill holder and turned by hand over *L* while being fed up by the tail spindle, until the lips are backed off to the cutting edges.

A Stop and Ejector for the Spring Collet

Fig. 5 shows how the work *P* in a spring chuck is held in a positive position by the stop *Q* and then thrown out when the chuck is loosened, by means of the spring *R*.

The Professional Educator and the Trade School

By Entropy

Mr. Drew certainly gives the views which I have expressed of trade schools all the support which any man can ask in his article at page 382. More than that he opens up another line of thought that must be of interest to many of your readers; that is, regarding qualifications for teaching and chances for paying jobs in that line. The importance of the mixing in of practical men along with professional educators is something which all your readers will probably admit. The way in which it can be done is not so easily settled. There are, as Mr. Drew says, few men who know the theory and practice of their trade well enough to teach it, who use tolerable English and have the ability to exert a good influence in a school. These men are few, but the few are undoubtedly in the ranks of your readers, and to those few I wish to say that the case does not seem to me to be so hopeless as Mr. Drew paints it.

Case Is Not Hopeless

I believe that I have one time or another admitted that I once taught school. I have not claimed, however, to have been any ornament to the profession; but nevertheless some of the things which I picked up serve to give me a greater respect for the abilities of professional educators as a class. There are no doubt a great many of them who may make fool remarks when they are visiting machine shops, but the only reason why they make more breaks than practical men is because they visit shops more freely than practical men visit schools. Their profession is a distinct one, just as a doctor's or a lawyer's. The difference is this, that the educational system as a whole is becoming more and more closely allied with the active work of the world and in that change it is becoming necessary for the professional educator to know something of the ways of the world. The point now is as to whether it is most desirable that the latter-day educator should be a professional educator who has learned to do something useful, or a mechanic or engineer who has learned to teach.

The Professor in the Shop

Since the professional educator refuses to be taught useful things at present, the only hope is that the teaching forces may be recruited from the ranks of engineers who are willing to learn to teach. Suppose that some college professor should come to your shop and say that he would like to be your foreman, that he had taught a hundred boys and he would like to take charge of a hundred men and take the salary that you have been in the habit of paying for that work. Would you put him on the job? Not a bit of it. You might tell him that you would put him on scratching castings or something of that sort, and if he could show you that he was capable you would be more than glad to advance him. Now the professional educators do better than that; they offer, according to Mr. Drew, $800 to $1500 a year to men whom they expect to be absolutely green at the teaching business, in the hopes that they may pick it up shortly and be worth something.

What Teaching Offers the Mechanic

Suppose one of your readers who has the qualifications which Mr. Drew calls for decides to take a chance on the teaching business, what can he expect? He may expect anywhere from $800 to $1500 per year to start with, for which he must give usually an average of 6 to 8 hours per day for about 30 to 36 weeks in the year; in some places this may run to 40. But in any case it does not mean more than half the time demanded in commercial life. The rest of the time is free to use to earn money at any profession that he may wish. As he grows in experience in teaching and begins to get his knowledge into such form that he can transmit it to others, his salary grows and his hours of teaching decrease. He may expect as a professor to draw from $2000 to $2500 per year and actually to teach about 10 to 16 hours per week.

If he is doing professional work along the same lines that he is teaching, then he may find that one helps the other, and that his teaching becomes almost a pastime; his professional work keeps him supplied with new points, problems and data for his classes. If he becomes the head of a department he may draw from $2500 up to and past $4000 or $5000 per year, but with correspondingly less opportunity to care for outside work. A good proportion of the men holding these positions today are not men of any greater capability than thousands of men who can make only equal salaries for all the year round work.

Not All Pastime

So much for money; how about the work? To say that teaching a subject may become a mere pastime is true; but unless the teacher is actively interested in the subject and is a master of it, and has a personality that makes him a master of his pupils, it will not be true. There is a very decided nervous strain in standing up before a class of boys of 18 to 24 years of age, expecting at any minute a question that will prove a poser or some breach of discipline that will make you wish you had a six-shooter handy, and a suspension of all law for about a minute. Unless you feel sure that you know what you are talking about and you feel that your personality is such as will quiet a mob with a look, stay out of teaching.

Too often a practical man takes up teaching with all fervor, and the desire to teach things the "way they are done." But when he comes to look over his stock of knowledge he finds that it is a hodge-podge of useful information in one little, narrow branch of the profession. He has an idea of the fundamental principles on which his work has been based, but those principles have been covered up so long in a mass of detail that they appear hazy and unimportant. Too often this man does one of two things in this predicament: He may make his instruction a detail of his own practical experience, teaching his students just what would be of use to them if they followed his track, but what is useless to them in any other line; or he may get discouraged, pick up a text-book, and follow that as a line of least resistance, forgetting ultimately that there are any practical uses of the principles there laid down, and looking on them as only nicely conceived mathematical problems. Either of these two courses is fatal to both teacher and student.

The only safe course for the newly fledged teacher is to rely on fundamental principles, which he may find stated in any text-book, and from these to lead on to practical use of those principles, taking his problems from the surroundings of his pupils or such of his past experience as they may understand.

The great telephone growth in the United States during 1906 is indicated by the following figures, which relate only to the Bell telephone companies. On December 31 last there were 7,107,835 instruments in use, 1,436,236 miles of toll line, 2,385,742 miles of underground wire, 11,373 miles of submarine wire, and an aggregate of 6,080,282 miles of wire devoted to telephone service. The stations number 2,715,367, and the employees 90,000. Within six years there has therefore been an increase of 349 per cent. in the total wire mileage, an increase of 239 per cent. in the number of stations, and an increase of 171 per cent. in the number of employees.—*The Engineer.*

Iron and steel manufactures exported in the calendar year 1906 aggregated 172½ million dollars in value, against 143 millions in 1905, 128½ millions in 1904, and 99 millions in 1903, having thus increased 75 per cent in three years.

The Air Furnace in Gray-iron Founding

Showing Its Advantages Where It Is Desirable to Obtain Uniform Mixtures for Any Work and Giving Details of a Successful Furnace

BY HUGH DOLNAR

The Ferro Machine and Foundry Company, Cleveland, O., U. S. A., produces principally either small gas engines complete, small gas-engine parts wholly or partly finished and gray-iron castings, largely small gas-engine cylinders for automobile builders. It is among the very few American gray-iron foundries which employ the air furnace, mainly, for melting. Mr. Blunt, the superintendent, prefers the air furnace, with natural draft and primary charging only, to the cupola, with continued charging and the air blast, because of the certainty of the constitution of the melted metal and the uniformity of the temperature of the metal delivered by the air furnace to the ladles.

With the air furnace the charge of iron, pig and scrap to be melted is first placed on the furnace hearth, which may be nearly flat, slightly inclined in all directions, however, to the tapping hole, so that the hearth can be completely drained of molten metal.

Different Air Furnaces

In the diagrams given herewith various forms of air-furnace hearths are shown, some in trough form, and some flat; those shown as flat are inclined in all directions to the tapping hole, placed about 2 inches below the high edges of the hearth.

The melting equipment of the Ferro foundry consists of one new "Westinghouse" air furnace, 15 tons capacity for motor-car cylinder castings, or 20 tons capacity for bed-plates or heavy castings; one air furnace, originally 5 tons capacity, now being changed to 10 tons capacity; one cupola, 60 inches diameter of inside lining, and three crucible furnaces taking 180-pound pots for brass or iron melting—natural draft for brass, draft forced with air hose for iron melting.

The Ferro practice is to pour cylinders from the air-furnace iron, general jobbing work from the cupola, and special jobs, calling for peculiar mixtures, from the pots.

With the air furnace all of the metal to be melted at one heat is charged on the hearth, and the charging door is then closed, no more iron being added during the heat.

Cupola Charging

Cupola charging is wholly different; kindling wood first, then coke or coal, then metal, and then more fuel and more metal charged from the scaffold door at intervals as may be desired, the melted metal running down and being tapped into the ladles as the pouring proceeds. The melted metal varies in constitution continually, because the more easily melted metal is melted first and is therefore the first iron to come down and go into the first ladles filled, and because the different chargings into the cupola vary in constitution.

With the air furnace the metal charged on the hearth is subjected to the heat of the fuel until the whole charge is melted and lies in a pool on the hearth, where it may be inspected, and may be stirred and mixed through the puddling door by the use of puddling bars of iron or of green hickory wood. With the air furnace the fuel is entirely separated from the charge, which is on the hearth, kept away from the grate and the burning fuel by a bridge wall, so that only the flame and products of the fuel combustion can go to the charge which is to be melted.

There are four distinct forms of air furnaces. Two, the "Westinghouse" and the "Camel's-back," have flat hearths, inclined to the tap-hole only enough to insure complete draining; while the hearths of the other two forms, the "English and

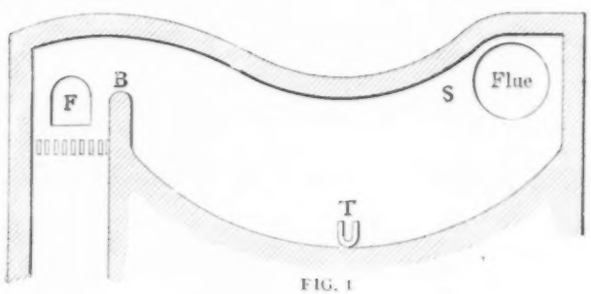


FIG. 1

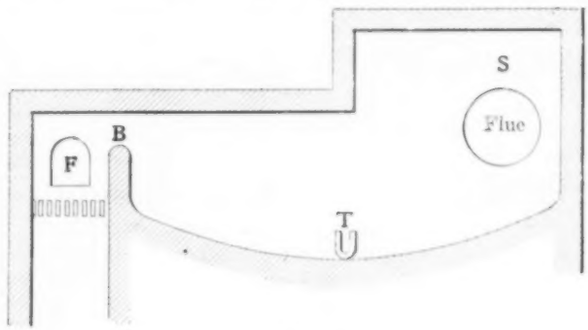


FIG. 2

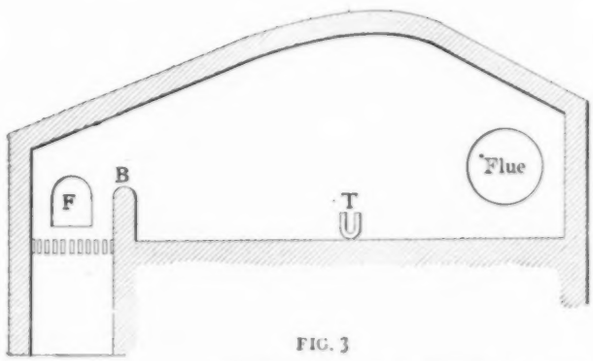


FIG. 3

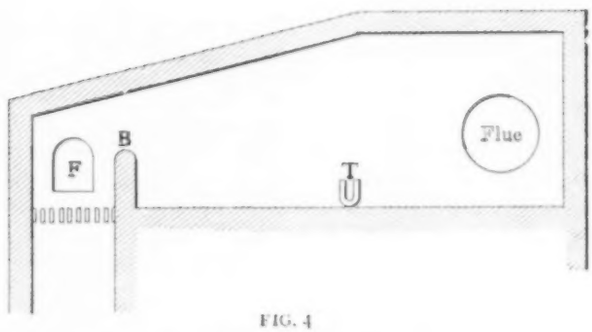


FIG. 4

FRENCH AND ENGLISH, PITTSBURG, CAMEL'S-BACK AND WESTINGHOUSE AIR FURNACES

French" and the "Pittsburg," have hearths in basin form, the English and French hearths being much more deeply depressed in the middle than the Pittsburg.

The aim of the air-furnace constructor is to keep the velocity of the products of combustion constant, so that all parts of the charge on the hearth shall be equally subjected to the heat, and so that as much of this heat as possible is transferred to the charge in the form of useful melting effect.

How They Are Made

Figs. 1, 2, 3 and 4 are diagrams showing the interior forms of the French and English, the Pittsburg, the camel's-back and the Westinghouse air furnaces, respectively.

Fig. 5 is from the working drawings of the Westinghouse air furnace as erected by Mr. Blunt. In these diagrams *F* is the firing door, over the grate, and *T* is the tap hole, always placed at the low point of the hearth.

All air furnaces have a grate on which the fuel is burned by natural draft, accessible by a fuel door, a bridge-wall between the grate and the hearth, and a flue opening to the chimney, placed low down at the end of the hearth chamber farthest from the grate. All have charging doors through which the charge can be placed on the hearth, and puddling doors above the charging doors, and tap holes from the lowest point of the hearth.

Action of the Gases

Referring to Fig. 1, the idea is to force the products of combustion downward as they come over the bridge-wall and make them heat on the top of the charge and deliver their heat to it as they pass on in their way to the flue. The heat and volume of the products of combustion increase and the velocity increases also, of necessity, all the way to the flue, and the space marked *S* is very hot. Heat at *S* cannot affect the charge much, as it is too far away. This form of air furnace fails to do what it is especially intended to do and takes more fuel for the same melting effect than either of the other air-furnace forms shown.

The camel's-back uses a flat hearth and increases the passage area from the bridge-wall to the hearth, and then diminishes the area to the flue. The shape is awkward and the camel's-back uses more fuel than the Westinghouse, and is slower in action.

The Pittsburg makes a sudden increase in passage area, which is comparatively restricted from the bridge-wall to the middle of the hearth, so that the combustion product's velocity is high from the bridge to the beginning of the abrupt rise in the furnace top; and here, again, the space *S* above the flue is very hot and is away from the charge.

Uniform Velocity

The Westinghouse form of regular increase from the bridge-wall to the flue gives the nearest approach to uniform velocity of the travel of the products of combustion from the bridge-wall to the flue, works more rapidly and uses less fuel than either of the other forms shown.

Mr. Blunt is familiar with the action of the cupola and of each of the forms of air or reverberatory furnace here shown, and it is his opinion that a foundry which does general job founding, some special-mixture founding in small lots, in addition to a principal production of some one standard article, as in the case of small gas-engine cylinders, should have about the equipment here described.

Comparative Costs

The cupola brings down iron at a less fuel cost than any form of air furnace, and the air furnace can be mishandled so as to waste iron and change the constitution of the iron delivered to the ladles by burning part of the original charge, the same as the cupola can. The cupola has the generic fault of mixing portions of successive chargings with each other, which is impossible with the air furnace, because it is charged but once, at the outset of each heat.

In charging the air furnace, the primary draft is always checked by placing the heavy scrap on the hearth next to the flue, when melting a charge of less than the full capacity of the furnace.

In summing up Mr. Blunt said that good castings could be had by melting with the cupola only, provided the melting was under sufficiently careful and intelligent supervision; but that it was an easier and surer matter to obtain a uniform product from the air furnace, where the whole charge can be melted at once, can be thoroughly mixed by puddling, and can be poured at any desired uniform temperature; while for special mixtures of exact constitution the pot was the only thing for melting the iron.

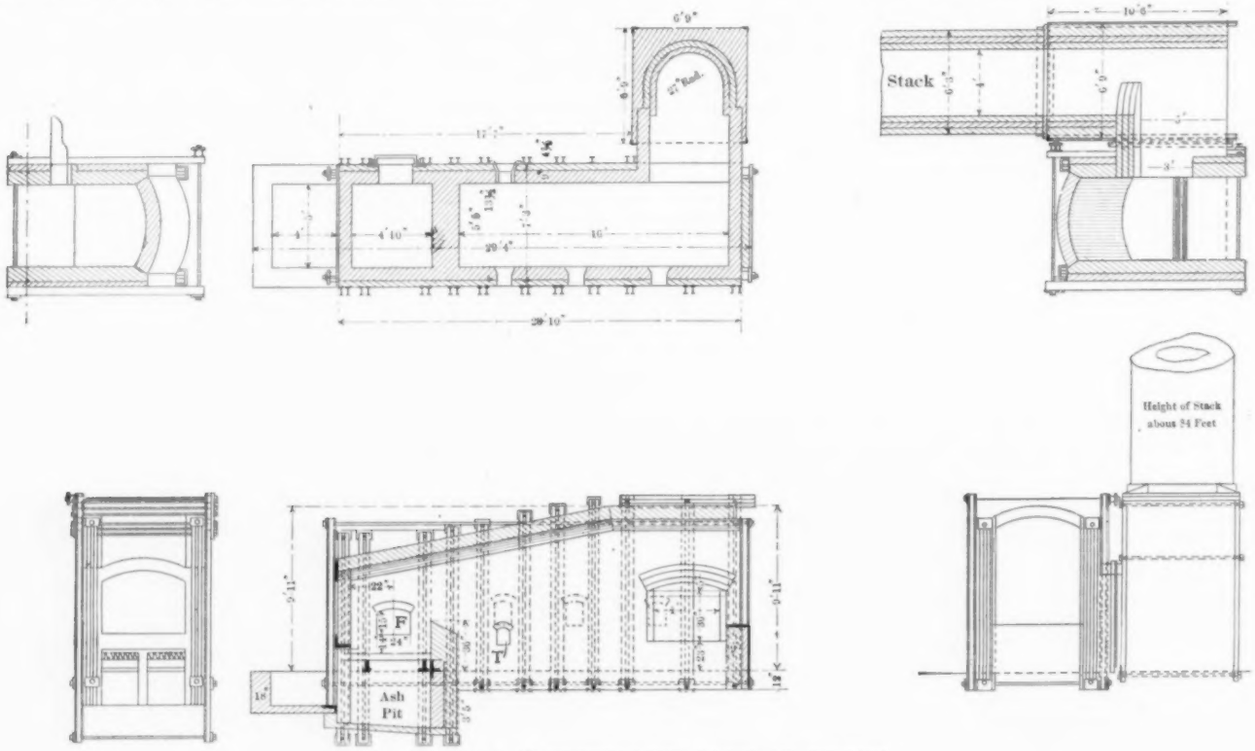


FIG. 5. DETAILS OF WESTINGHOUSE 15-TON AIR FURNACE

Universal Milling Machine

The illustrations show a recently designed milling machine which is one of a line of universal millers built by the R. K. LeBlond Machine Tool Company, Cincinnati, O., this particular tool being designated by its builders as their No. 3 universal machine.

Spindle Construction and Drive

Fig. 1 gives an excellent idea of the appearance of the miller, which is in general design quite similar to the plain milling machine included in the same line. The line engravings illustrate various features of construction, the first of these, Fig. 2, showing clearly the spindle and its bearings, which are alike in both the universal and plain miller designs. As will be noticed, the front spindle bearing is tapering and has a hardened-steel sleeve pressed over the front journal. This runs in a box made of cast iron, while the rear journal, which is straight, runs in a bronze box, which is fitted to a taper hole in the column. This box is split and can be drawn into the taper to take up the wear on the rear journal. The thrust is taken by one hardened steel and one babbitt collar. An oil slot is milled in each box; this slot is filled with felt and filters the oil, a recess in the column acting as a reservoir. The provision made for adjusting the spindle bearings is clearly indicated in the drawing and needs no description.

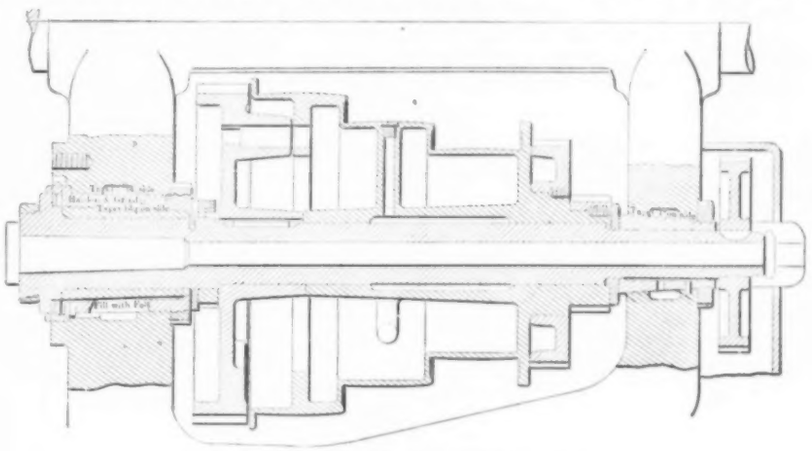


FIG. 2. SHOWING HEAD CONSTRUCTION

The driving cone has three steps, and with the double-friction back gears gives a range of 18 spindle speeds. An engraved speed plate indicates the various speeds obtained, as well as giving the surface speed in feet per minute for various diameters of cutters, at 40, 50 and 60 feet. These can be doubled for 80, 100 and 120 feet, and halved to obtain 20, 25 and 30 feet. In this manner a complete range from 20 to 120 feet per minute is indicated.

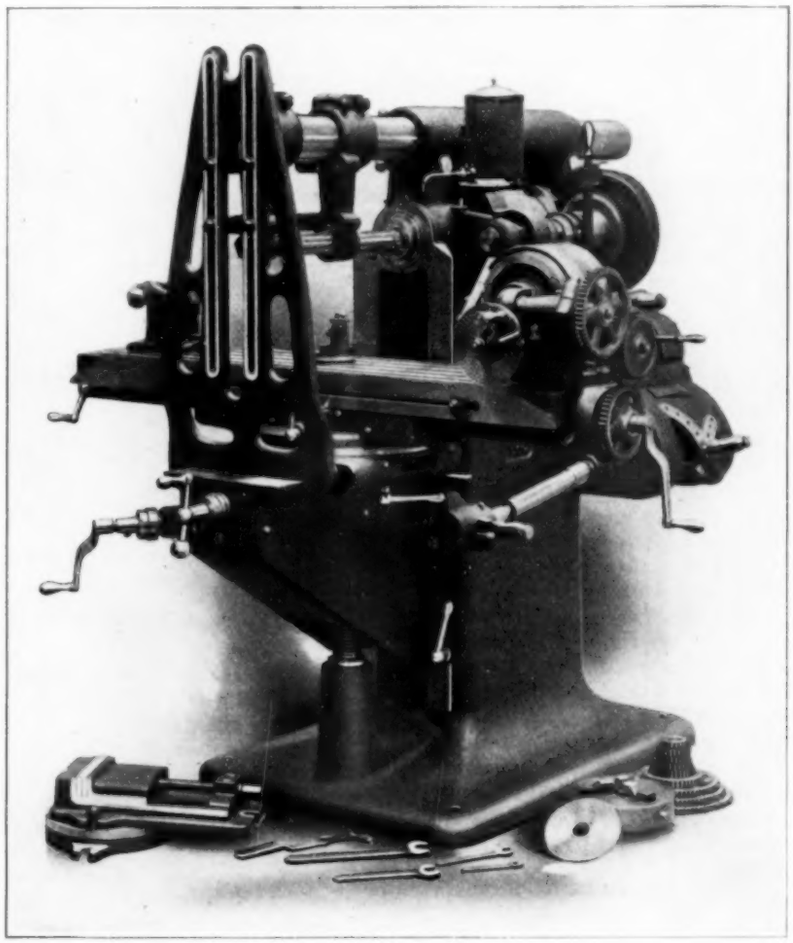


FIG. 1. UNIVERSAL MILLING MACHINE

Arbor and Support

The arbor is driven by a clutch milled in the spindle nose. The end of the arbor is tapped out to receive a long bolt that passes through the spindle, and with this bolt the arbor is drawn into the taper seat and also forced out when desired.

The overhanging arm, which is made from a bar of steel, carries two arbor supports, one of which has a taper bronze bush for receiving the end of the arbor. The other is bushed to a large diameter to support the arbor in the middle or wherever the cutter will permit. Both these supports have four lugs cast on them, so that either can be bolted to the knee brace. The latter is made in one piece to insure rigidity. For work that will permit a short arbor the middle arm can be turned up out of the way and the end of the arbor carried by the outer support and the brace.

Feed Mechanism

The feed box shown at the side of the machine is driven from the spindle by means of spur gearing, and gives 16 feed changes, the lower lever giving the fine and the upper the coarse rates of feed. The handles are entirely independent, and can be worked separately or in unison.

The feed mechanism in the saddle and knee, as shown in Fig. 3, is of interesting construction. It is powerfully geared and steel gears are employed throughout. The feed is reversed by a plate at the side of the knee. The drive is transmitted through a wide-face intermediate gear to the sleeve-gear shaft *A*, and this shaft has keyed to it a sliding clutch that can be engaged with the clutch in the bevel pinion *B*. This operates the large bevel gear on the vertical telescopic screw for obtaining the vertical feed. The cross

feed is obtained by engaging the sliding-clutch gear *C* with the clutch on the cross-feed screw. The levers that operate the cross- and vertical-feed clutches are located at the front of the knee.

The table feed for this universal milling machine is driven through the long sleeve gear by the gear revolving on the cross-feed bearing, through which gear the cross-feed screw passes without touching. The drive is then through the vertical bevel-gear shaft to the gear that drives the table screw in the saddle.

All feeds have permanent stops for tripping the feeds at the end of their movements; the feeding mechanism has been so arranged as to allow a series of lateral and transverse ribs throughout the knee and to eliminate all slots and openings except for the cross-feed nut, and this is made of the smallest permissible area and is covered by sliding covers to protect the working parts from chips. In the plain miller referred to above, the table feed is operated by direct spur-gear drive, the feed being engaged and reversed by a single lever. The spur gears that engage with the screw-operating gear in the saddle are driven by spiral gearing and the thrust is taken by ball bearings.

Table, Saddle, Etc.

The table is heavy and the bearing is taken on the outer dovetail bearing, the sliding surfaces being lubricated by felt oil pads. The working surfaces are wide, and in the oil pocket at the end of the table a bearing has been placed to receive the dividing head. This adds 4½ inches to the actual working surface of the table when using the head. The table made in this way permits spiral gears, cutters, reamers, etc., to be cut on the plain machine with the spiral attachment. The table-feed screw is made with a quick lead and the screw is geared to return the table 0.8 inch per revolution of the return crank. The two members of the saddle on the universal machine are clamped by three bolts in a single T-slot close to the outside of the saddle. This allows the table and saddle to be turned completely around.

Dr. C. P. Steinmetz has been granted a patent for an ingenious invention, the object of which is to provide an efficient variable-speed alternating current electric motor. In this machine the secondary member is supplied with a low-frequency current derived from the primary member, which current goes through devices for varying its electromotive force, and thus controls the speed of the motor. Reducing the e.m.f. of this circuit causes the motor to approach synchronism, and complete short-circuiting results in running the motor at synchronous speed. If this works out in practice as well as many of his inventions, it will open up a much wider field for the use of alternating current.

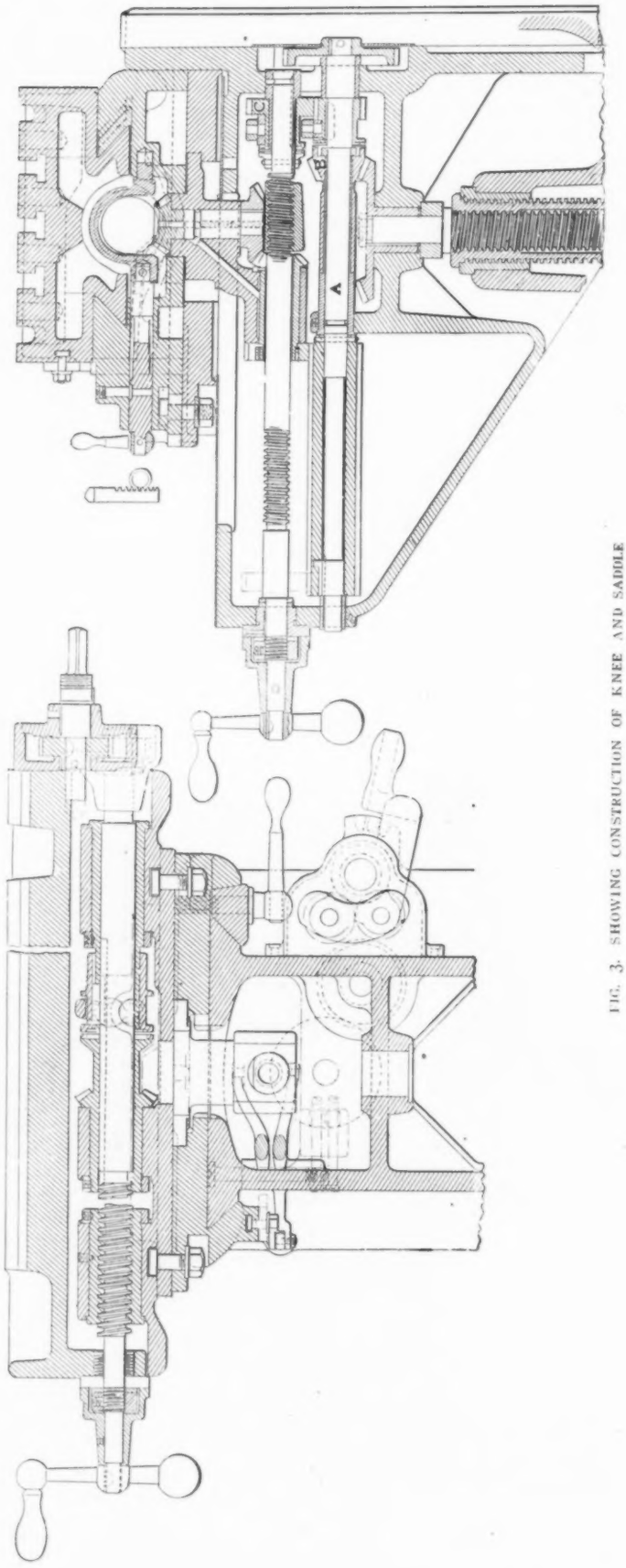


FIG. 3. SHOWING CONSTRUCTION OF KNEE AND SADDLE

Practical Letters From Our Readers

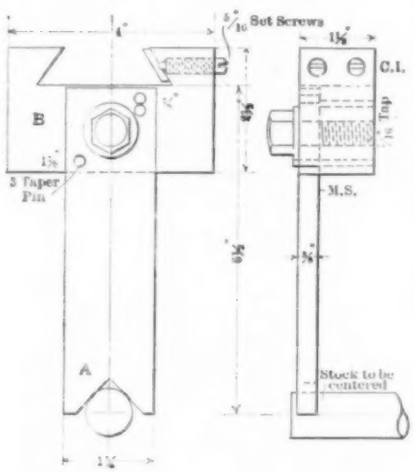
A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Centering Round Stock in the Sensitive Drill

I had a lot of 7/8-inch round and an equal number of 1 1/8-inch round pieces of stock to center for the lathe. I used to center these, after filing off the burs left by the hacksaw, by using a bell center punch and then drilling and countersinking in the speed lathe. I needed a centering machine, but could not get one. I inclose a sketch of the attachment I made for the sensitive drill. It was new to me, though it may be old.

In use the attachment is fastened to the column of the drill, and the cone center which holds the bottom of the piece is adjusted to the proper hight to bring the upper end of the stock just above piece *A*. The stock to be centered is pushed back into the V and drilled without having been center-punched, using a short 1/8-inch



CENTERING ROUND STOCK IN THE SENSITIVE DRILL

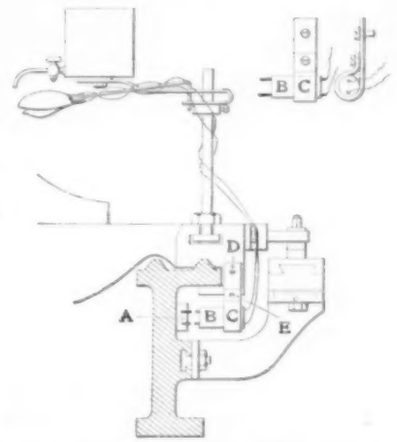
drill, or a combination drill and countersink.

The sketch shows the attachment set for 1 1/8-inch round or square stock, the taper pin being in the hole marked 1 1/8-inch. To use this rig for 7/8 stock, I loosen the cap screw, remove the taper pin, shift piece *A* toward the chuck, and put the pin in the hole marked 7/8-inch. *A* fits snugly in *B*. The attachment may be used for several sizes by moving *A* to the correct position, tightening the cap screw and drilling and reaming a new hole for the taper pin. By means of this rig I have gained both in speed and accuracy in centering.

F. B. FAULKNER.

Lighting System for the Lathe

We formerly used loose wires with the attendant bother of having them cut off



LIGHTING SYSTEM FOR THE LATHE

or tangled up in the cuttings. The new method is shown in the illustration.

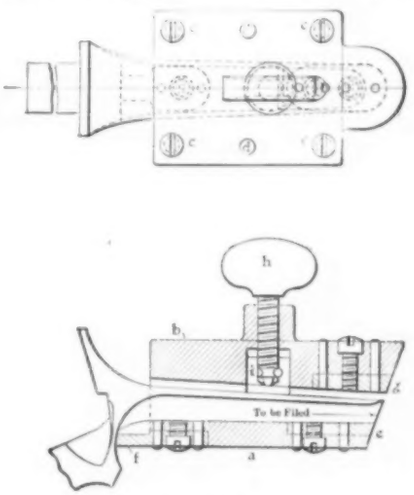
A is a strip of wood 9/16x1 1/8 inches, with two slots from end to end 1/4 inch deep by 1/32 wide. This strip of wood contained the live wires, and was fastened to the bed in the position shown. The connection to the feed wires was at the headstock end. The feed wires were made by rolling some old 1/4-inch copper wire, so that it was about 5/16 inch wide by 3/64 inch thick. These were pressed into the slots in the hardwood strip. The brush holder *C* was made of a piece of 1/8x1 1/2-inch spring steel bent as shown, with a piece of hardwood *B* with two holes bored in it from end to end. This was split, and the two brushes were laid in. The brushes were made of the same stock as the live wires. One end was drilled to receive the wires from the lamp. The other end was slotted to receive a piece of thin bronze 5/16 inch wide at the part where it was soldered into the wire in *B*, and tapered to 1/8 inch at the contact end. The edges were slightly turned to prevent its jumping off the feed wire. The brushes are not shown in contact in in the sketch. The brush holder was fastened to the carriage by the screw *D*. The screw *E* clamped *B* in *C*. It can be easily slackened so that *B* can be removed for repairs.

A. GREASER.

A Filing Jig

The illustrations show a jig for filing the taper on the end of a gun tang. This is a job that is very difficult to machine so that all are exactly alike. When it comes to handling thousands of pieces it is essential that the parts should be interchangeable so as to lower the cost of assembling. Using this jig the pieces fit the gage perfectly.

The two pieces *a b* are made of machinery steel and fastened together with four screws *c c c c* and two tapered dowel pins *d d*. A tapered slot is milled in the bottom piece *a* to fit the tang. On each end are fastened tool-steel pieces *e f* with one screw and two dowel pins. *f* acts as a stop while *e* is shaped to fit the model. On the end of the piece *b* is also fastened a tool-steel piece *g* with one screw and two dowel pins; this is also shaped to fit the model. In the center of the top piece *b* is placed a thumb screw *h* with a round shoe *i* in the bottom and held an easy fit by a pin. This clamps the work in the jig while being filed. The whole jig is



A FILING JIG

case-hardened. The tool-steel end pieces are hardened so that the file cannot touch them.

R. A. ALMOND.

An Expanding Mandrel and a Counterboring Kink

Your correspondent "Rover" shows an improvement on an expanding mandrel, shown in a back number, and I agree with him that the construction shown is much to be preferred, both for cheapness and lasting qualities. Both types, however, have one or two points that may be improved.

First. Both types will take a permanent set after some actual using, which leaves the end surrounding the taper end of the screw larger in diameter than intended. This requires filing or grinding down and will cause a break, after one or two of these sizings.

Second. In both types the sharp edges of the slots are acting like a die and have a tendency to cut or wear down the screw rapidly, even if it is hardened. I don't mean to say, however, that they are not practical to make for short jobs, but for long wear I prefer the mandrel shown in Fig. 1.

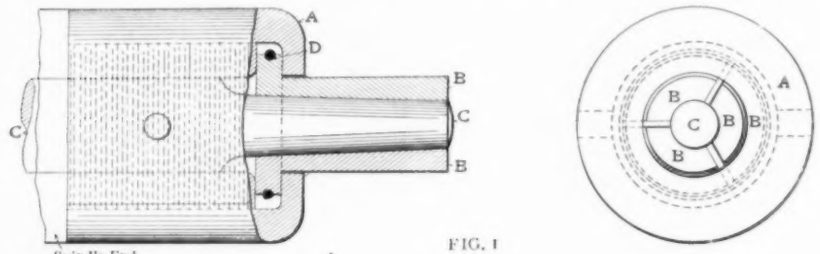


FIG. 1

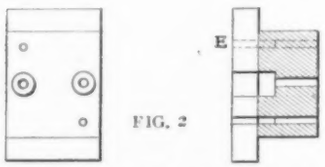


FIG. 2

FIG. 3

AN EXPANDING MANDREL AND A JIG

This consists of four parts. *A* is a cap to fit the end of the spindle, and is bored out as shown. B is a steel sleeve cut into three separate parts; *C* the mandrel proper, which is a good fit in the hole of the spindle, and *D* an endless piece of rubber or a spiral spring, holding the three pieces of *B* in contact with *C*. Sleeve *B* is bored out taper to fit *C* before slitting, after which both are hardened and ground. The thickness of the projecting shoulder on sleeve *B* must be such that it allows the sleeve to float between the end of the lathe spindle and the inside recess of the cap *A*, without having any end shape. The groove in the outside of the sleeve is provided to receive *D* as explained above.

This mandrel is operated by a screwed rod and hand wheel at the near end of the lathe spindle, or by the usual chuck-closing device found on all wire-feed screw machines. In operation it will be found a very firm and true-running device, expanding all ways cylindrically within its range, and more durable than any other expanding mandrel I know of.

A Counterboring Kink

Fig. 2 shows a little shop kink I found very handy in counterboring a lot of ebonite blocks used in telephone installations. Previous to using this little device no end of money was spent in making counterbores, as shown in Fig. 3, enlarged. Ebonite being very hard on tools, it didn't take long to round the edges and reduce the diameter of the counterbored hole. So I tried this scheme, which is nothing more than a common twist drill, ground square on the end and a hardened guide plate *E* to locate the drill correctly in relation to the previously drilled hole. I found that this little dodge saved me no end of worry, because it is a simple matter to regrind the twist drill should the cutting edges get rounded.

M. Bode

Jig for Small Motor Frames

I inclose sketch showing jig used for drilling screw holes for pole pieces in an odd-shaped casting for small electric motors.

In Fig. 1 sides *A* and *B* are made of boiler plate of octagon shape. Cast-iron flanges are screwed to these, fitting into machined holes of the motor case, thus serving as centers. To remove the casting from the jig, the nut at *C* must be removed, so that plate *B*, with drill guides *D*, can be lifted off and the casting replaced by another.

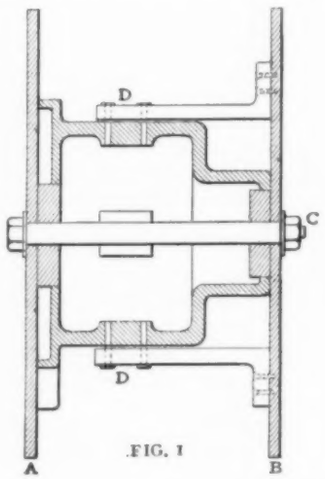


FIG. 1

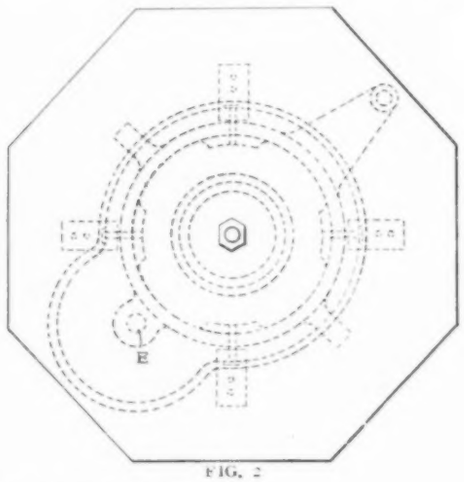


FIG. 2

JIG FOR SMALL MOTOR FRAMES

A square shaft binds flanges *A* and *B*, so that both flanges must be square with each other on the octagon. This shape was chosen so that the jig could be turned readily, and save time which would be expended clamping the casting. A pin, not shown in the sketch, passing through flange *A*, enters hole *E*, shown in Fig. 2, and serves as an index.

R. E. Quire.

Crane Trolley-wheel Troubles

Upon my trip East two years ago I thought I would get a job as an erector of electric cranes. This was made possible through an acquaintance formed ten years before. I entered many of the large shops as erector and trouble man. The engineer of my concern asked me to say in my letters just what I thought of the design and construction of their cranes.

One large tool builder in Pennsylvania had a large I-beam crane with the top of the I's sway-braced by a channel beam riveted in place with its flanges down, which was causing trouble.

Upon investigation I found that the trolley was constructed as in Fig. 1 of Skribsto's letter, page 385. By way of demonstration a large machine was hung on the crane. Upon moving the trolley along the beam, large flakes of metal were taken off because of the slipping due to the large and small diameters of the face of the wheel. I condemned it, and my report read that it looked like a roller skate turned upside down, and that the apprentice boy must have had a hand in constructing it. My advice as to a remedy was taken and wheels with tread and shaft parallel, as per Fig. 5, page 385, were installed. The flaking under the wheels stopped and the load moved much easier.

Another case of trouble was with three cranes across a building 210 feet wide, making about 68 feet of span for each. One of the cranes would jump and chug sideways on the track girders when about halfway between posts. Some two or

three handfuls of metal flakes were found in one place, where they had dropped from one of the wheels. On testing the alinement of the crane, this wheel was found to be out of square, an amount equal to 25 inches in 200 feet. Shimming the wheel into line stopped the trouble.

ULLEY.

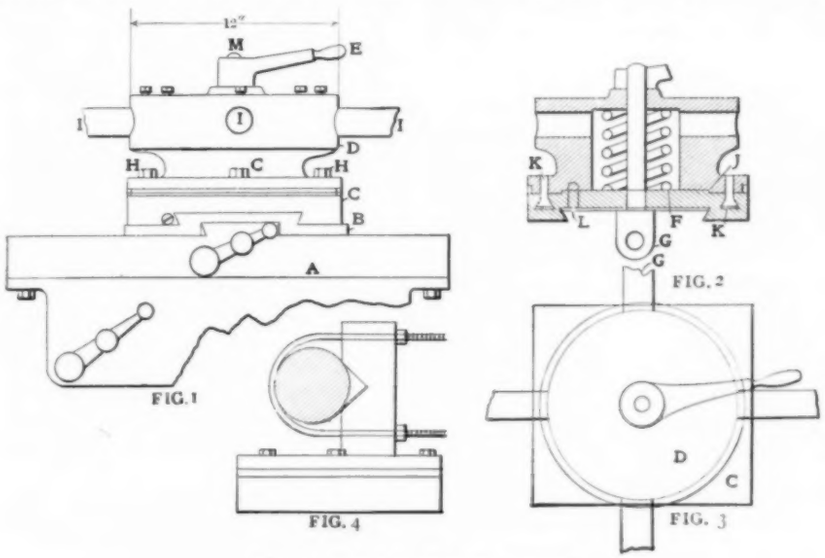
Using an Old Lathe as a Turret

As nearly every machine shop has one old lathe standing in some corner I am going to tell how I once made use of one.

In Fig. 1 *A* represents the carriage; *B* is a cast plate 12½ inches wide and the full length across the carriage. This is planed out square to drop down over the guide on the carriage. It is also drilled and counterbored at each corner to receive bolts that are fitted to the usual slots in the carriage. The top side is planed to receive the sliding head *C*. *B* is also slotted out in the center the same width and distance as the carriage to allow the nut *G*, Fig. 2, to extend through to the cross-feed screw.

The turret head could then be run along and used to bore or turn large work in the chuck. *C* is a 12-inch square casting machined as in Fig. 2. The slot shown at *K* is turned all the way around, so that the bolt *H*, Fig. 1, will allow the head to be tightened at any square point. At one point this slot is chipped out to let in the head of the bolts.

In Fig. 1 *D* is the turret head, showing the cutter bars *I*, also the lever *E*, for tightening the head. This head is machined, as shown in Fig. 2, to fit freely



USING AN OLD LATHE AS A TURRET

over shoulder *J* and to receive spring *F*, which must be of sufficient strength to lift the head free of lock pin *L*, that it may be turned to any point desired. The stud *M* is to receive the tightening lever *E*, Fig. 1. By removing the nuts from the bolts in each corner of *B*, Fig. 1, you can lift the whole thing off and substitute the ordinary cross slide when necessary.

Fig. 3 shows a top view. In Fig. 4 is shown an angle head which may be substituted for *D*, and used to hold flat work on one side and round work on the other, while being bored by cutter in or on the spindle. By having a good collection of cutters and different-sized bars for the turret head, also a cutter head to fit the spindle of the lathe, it is surprising how much work can be done on this machine.

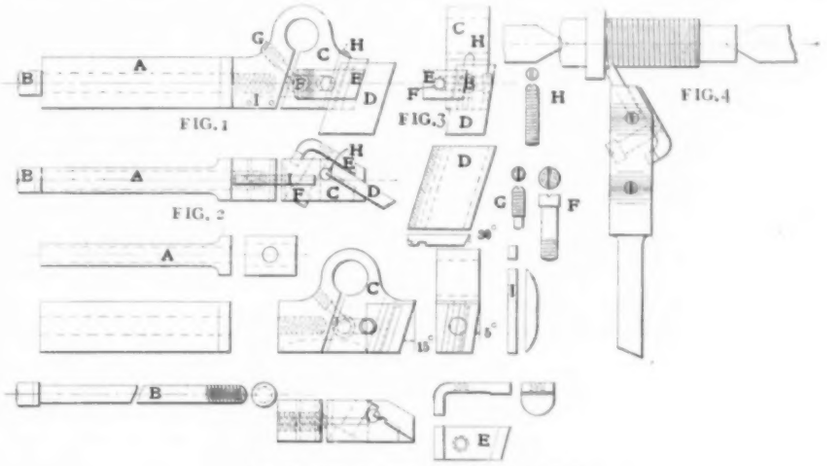
For a feed I ran a 12-pitch screw through the end of the bed and ½ inch above the center of the bridges in the lathe, then fitted a nut under the carriage with the lever projecting just enough to handle it. While this method of feed worked very nicely as long as it was kept clean, still as a whole it did not suit me. Therefore, I do not give a sketch of it.

I should advise every jobbing shop that has a machine lying around that is of little use as it is, to rig it up in this manner. You will find work for it every day.

A. GREASER.

An Offset Spring Threading Tool

In the illustrations I show your readers a new-style spring thread tool. There are many reasons why such a tool will do better work. The main point is that it will cut a thread up to a shoulder and still the center of the cutting point is within the limits of the tool holder. This gives strength and therefore a heavier cut can be taken. As will be noticed, the cutter is held at an angle of 30 degrees in the tool holder and the left cutting edge only is tapered 30 degrees, thus we obtain our 60 degrees for the cutting of the V or the U. S. standard thread. The cutter in this tool holder is ¼x1¼x1¾ inches and for fine thread cutting, say 12 threads and finer, should have the corners, indicated by the dotted line in Fig. 4, ground off to permit still closer cutting to the shoulder. Cutters are of course interchangeable and can be ground without changing their form. They are re-adjusted instantly to the exact position when taken out for grinding during cutting operation. This tool is readily changed from a spring tool to a stiff, solid tool, and then we have four tools all in one, viz.: Spring offset thread tool, spring straight thread tool, solid offset thread tool, solid straight thread tool. The tool holder swivels on the shank so that the cutter may be set to the pitch of the screw you are cutting.



AN OFFSET SPRING THREADING TOOL

Fig. 1 shows side, Fig. 2 bottom, Fig. 3 front and Fig. 4 top view in relative position to the work. All views are actual size and all letters correspond in all drawings.

The shank *A* is made of bessemer steel, case-hardened, and holds the binding screws *B* for drawing the tool holder *C* into the shank. The tool holder *C* is split open to the upper or spring portion, made of tool steel and spring tempered. The cutter *D* is securely held by tongue and groove respectively and adjusted by

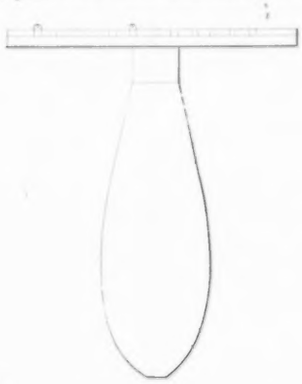
the screw *H* and clamped solid by the clamp *E* and screw *F*. By means of the screw *G* the tension of the spring is regulated or even made into a solid tool. The binding piece *T* prevents side motion.

F. H. LANDER.

Removing Burs from Small Screws

In reference to the information wanted on page 403, regarding the removal of burs from the slot of small headless screws, I offer the following, which was suggested to me, for cleaning the heads of small gold screws used in assembling eye glasses.

Several plates of brass, slightly thinner than the length of the screw, have from 50 to 100 holes tapped through them. These plates are then each fastened to another plate to which is attached a suitable handle, as shown in the illustration.



REMOVING BURS FROM SMALL SCREWS

A boy or girl can then fill one plate with screws while another is bringing a full plate into contact with a suitable felt wheel on the buffing head, and so removing the bur. If the screws are brought snugly against the bottom plate, there is no danger of them turning loose while being buffed.

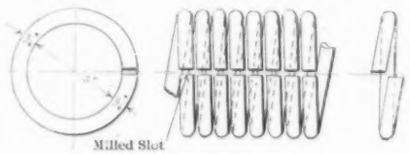
It may seem tedious to handle each screw in this way, but it is surely better than bringing them one by one against any cutting surface.

ARTHUR W. SCHOOF.

Cold-rolled Steel Rings

We needed some finished metal rings, 5 inches inside diameter and ¾-inch round stock, in large quantities, very material strength not essential.

At first these were made by casting and turning in a lathe, a special chuck being required to hold the piece. This was a hard job and made the ring cost too much. So now we do it this way: One end of a rod of ¾-inch cold-rolled steel is put through a hole in a 5-inch mandrel, which has been previously mounted in a lathe. The lathe is started and we wind the cold-rolled steel as shown in the illustration. This coil is now put on a milling machine and a saw cut run down it, making a separate ring for every turn of the coil. These rings, as they come from the milling machine, are of course open and the ends offset. So as to flatten and bring them to size, they are put into a former under a steam hammer, the former causing the ring to take the exact required diameter. Of course the faces of the cut in the ring are not parallel when it has been sprung flat, so a milling cutter is again run through to bring the slot to size and make the sides parallel. This done, a clean iron disk is forced into the slot and brazed. Thus, with a little filing, we have our finished ring much better and cheaper than by casting and turning it. If great strength is required, and facilities permit, the joint can be electrically welded.



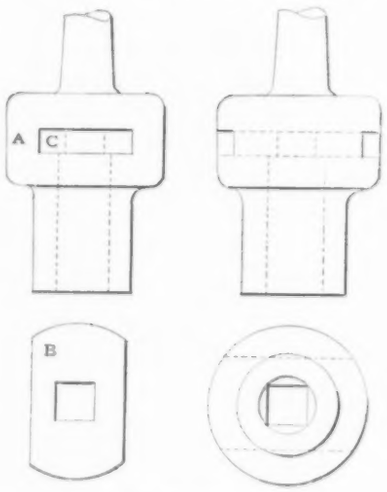
COLD-ROLLED STEEL RINGS

EGYPT.

A Tapping Chuck

The sketch shows a tapping chuck for use in the drill press, for tapping work clear through. This chuck is fast, as it does not require stopping the press.

The body *A* is of machine steel and is bored to fit loosely the shank of the tap. The tool-steel driver *B* is provided with a square hole to take the square on the end of the tap and is driven into a slot *C* formed in the shank. The tap can be inserted in the chuck while the latter is in motion, and is held in place by the pressure on the work; but as soon as it is through, it drops out of the chuck and through the slot in the drill-press table. Two taps are ordinarily used, the operator picking up one while the other is in the work.



A TAPPING CHUCK

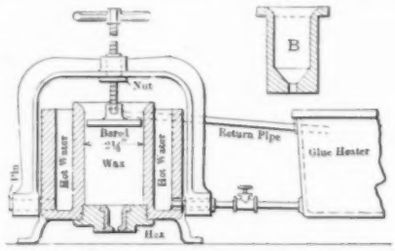
JAS. P. APPLEBY.

Wax Core and Fillet Machine

Some time ago I made a wax fillet machine which was used for making pattern fillets and vents for the foundry molds. I have had a few inquiries about the machine and thought some of your readers might be interested. Herewith I illustrate it.

The wax cylinder and water jacket are made in one piece supported on three feet cast on the clyinder. The bottom of the wax cylinder is threaded to receive a plug, and in this plug is a hole to receive plugs for various sizes of wax. This plug is made a loose fit, so that it may be put in through the top of the wax cylinder or by removing the threaded plug at the bottom.

The yoke carrying the plunger screw is hinged at the sides, so that it may be thrown back to allow filling the cylinder and inserting and removing the small plugs.



WAX CORE FILLET MACHINE

The water chamber, or jacket, is connected to the glue heater as shown, with a valve between to shut off when not in use, also to regulate the temperature of the wax cylinder. An overflow pipe is connected to the water jacket at the back near the top and returning into the glue heater.

At *B* is an enlarged or full-size plug, and after much experimenting I find this design gives the best results.

With this method for heating the wax cylinder, the wax can be kept at a uniform heat all the time, and the first cost of the machine is nothing when compared with results gained over any other method. It is clean, neat and compact, and always ready for use.

FOUNDRY.

Remarks about Two-cycle Gasolene Engines

I was glad to see someone speak a good word (at page 50) for the two-cycle engine for automobile work. Most of my experience with automobiles has been with motors of the four-cycle type, but I have often thought that if one-half the energy and talent that have been expended on the

four-cycle motor had been applied to developing the two-cycle, the relative popularity of the two styles of motors might be considerably different.

Prefers a Separate Cylinder Head

As to the style of the cylinder, I prefer one having the upper half of the crank-case and cylinder cast in one piece, but with the top end of the cylinder open and the head a separate piece. By making a projection on the head to fit into the bore of the cylinder, as shown at *A*, Fig. 1, it is very easy to make a tight joint for the head, simply by using a gasket of asbestos card wide enough to cover both the cylinder and jacket walls. I have had joints of this kind in use for several years, and they have never given the least trouble.

A Separate By-pass With a Valve in it

I prefer to have the by-pass from the crank-case cast separately, for, while this does not make the cylinder any simpler, it makes it easy to fit a butterfly regulating valve into the by-pass; and this is a very useful device for controlling the speed in a marine engine. Of course this adds one or two extra joints, but they are subject to low pressure only and will not give trouble if they are put together reasonably well.

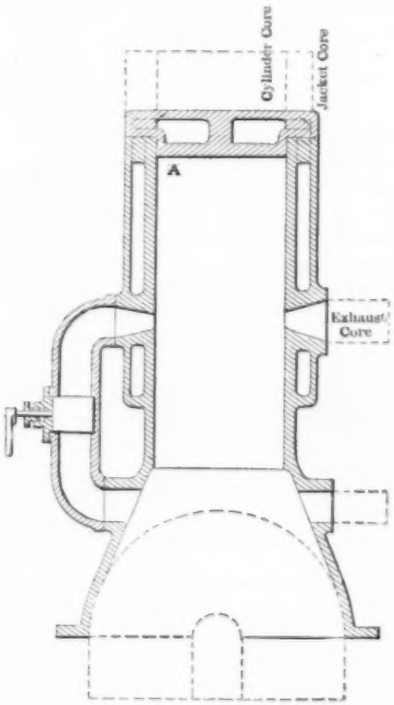


FIG. 1. WATER-COOLED TWO-CYCLE ENGINE CYLINDER CAST INTEGRAL WITH HALF OF CRANK CASE, BUT WITH SEPARATE CYLINDER HEAD

The Arrangement of Cores, Etc.

This design is an easy one for which to make the patterns, and they are usually made as follows: The main pattern is parted as sectional drawing shows in Fig. 1. The core print on the top end is equal in diameter to the outside of the water space. The water-jacket core projects beyond the cylinder the length of the above print, and the inside of this core projection is made to fit the core of the inside of the cylinder. The bottom end of the core can be rested on core anchors, or prints can be used and the holes afterward plugged. The exhaust and inlet-port cores are separate and are wired to the main core.

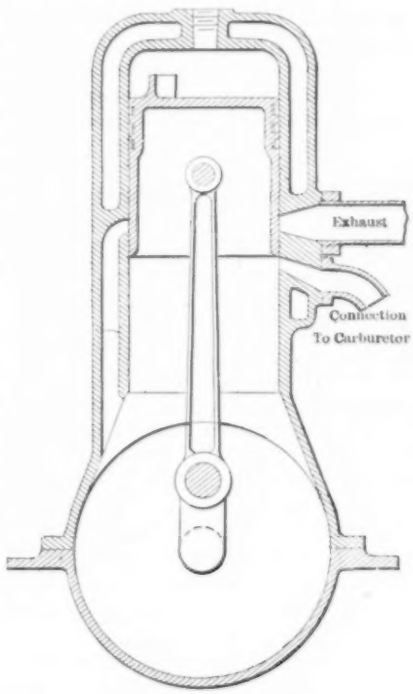


FIG. 2. THREE-PORT CYLINDER

A Design of the Three-port Style

In regard to the three-port engine there is one that is different from that illustrated by Mr. Lake. In the one to which I refer, the third port is under the exhaust port, and in such a position that it is uncovered when the piston is at the top of its stroke. At this time the suction in the crank case is the strongest, and the gases rush in as soon as the port begins to open. As a two-cycle engine usually stops with the piston at the bottom of its stroke, it keeps this third, or inlet, port sealed when the engine is not running, thus lessening the risk of flooding the crank case, in the event of the vaporizer valve leaking.

Objects to Valves in the Cylinder Head

In regard to two-cycle engines with admission valves in the cylinder head, it seems to me that in using them we are exposing our motors to one of the defects of the four-cycle system, as all valves are liable to leak or stick sooner or later, besides the danger of the spring breaking or weakening, or the valve stem itself giving way.

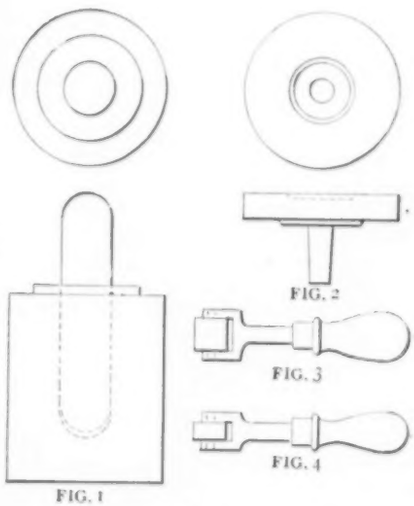
In using marine motors I have found that almost all my troubles were due to dirt at the needle valve of the vaporizer, or to water in the gasolene. W. Alton.

Diamond Powder and Its Use in the Machine Shop

The diamond used for this purpose, costing $85 per carat, is an inferior grade of diamond, not so hard as the black diamond used for drills and truing emery wheels, and not of a clear and perfect structure to permit it to enter the gem class. Many of them are a mixed black and white, others yellow and some pink; many are clear but flaky. Then there is the small débris from diamond cutting, which is reduced to powder and sells somewhat cheaper; but we find it more economical to use the above and powder it ourselves, as the débris from diamond cutting is of a flaky nature, and does not charge into the lap so well.

Assuming we have 25 carats to reduce to powder, we proceed as follows:

Into a mortar, as shown at Fig. 1, we place about 5 carats, using an 8-ounce hammer to crush it. It takes from 3 to 4 minutes' steady pounding to reduce it to a good average. Scrape the powder free from the bottom and the sides and empty into one-half pint of oil. The oil used is the best olive oil obtainable, and is held in a cup-shaped receptacle that will hold a pint and one-half. The 25 carats being reduced to powder, and in the oil, we stir it until thoroughly mixed, and allow to stand 5 minutes; then pour off to another dish. The diamond that remains in the dish is coarse and should be washed in benzine and allowed to dry and should be repounded, unless extremely coarse diamond is desired. In that case we label it No. 0. Now stir that which has been



DIAMOND LAPS AND TOOLS

poured from No. 0, and allow to stand 10 minutes. Then pour off into another dish. The residue will be No. 1. Repeat the operation, following the table below.

The settlings can be put into small dishes for convenient use, enough oil staying with the diamond to keep it the consistency of paste. The dishes can be obtained from a jewelers' supply house.

TABLE FOR SETTLING DIAMOND

To obtain No. 0—5 minutes.
To obtain No. 1—10 minutes.
To obtain No. 2—30 minutes.
To obtain No. 3—1 hour.
To obtain No. 4—2 hours.
To obtain No. 5—10 hours.
To obtain No. 6—until oil is clear.

Diamond is seldom hammered; it is generally rolled into the metal. For instance, we desire several pieces of wire of various diameters charged with diamond for use in die work. We place the wire and a small portion of the diamond between two hardened surfaces, and under pressure roll back and forth until thoroughly charged. No. 2 diamond in this case is generally used. Or you can form your metal any desired shape and apply diamond and use a roll, as Fig. 3, to force the diamond into the metal. You then have a file which will work hard steel, but remember the moment you crowd your diamond file, or lap, you strip it of the diamond, and it is consequently of no use. It is to be used with comparatively light pressure.

Copper is the best metal. It takes the diamond readily, and retains it longer than other metals; brass next, then bessemer steel. The latter is used when you wish to preserve a form that is often used.

For sharpening small, flat drills, say 0.008 to 0.100 (metric), a copper lap mounted on a taper shank, as Fig. 2, and charged on the face with No. 2 diamond, using pressure on the roll, makes a most satisfactory method of sharpening drills. The diamond lasts for a long time if properly used, and there is no danger of drawing the temper on the drill. It is much quicker than any other method of sharpening.

To charge the lap we should use the roll, Fig. 4, supported on a T rest pressing firmly against the lap, being careful to have the roll on the center; otherwise instead of charging the lap we should be grinding the roll. The diamond may be spread either on the lap or the roll, and the first charging usually takes twice the amount of diamond that subsequent charging takes. To avoid loss of diamond, wash the lap in a dish of benzine kept exclusively for that purpose. This can be reclaimed by burning the metal with acids, and the diamond can be resettled.

For the grinding of taper holes in hard spindles or for position work in hard plates, where holes are too small to allow the use of emery wheels, No. 1 diamond does the work beautifully. Or if you wish to grind sapphire centers or plugs as stops, etc., a bessemer lap made in the form of a wheel and charged with diamond on the diameter does the work nicely.

There are many ways which will suggest themselves where diamond powder can be used to great advantage. Nos. 5 and 6 diamond are used on boxwood laps, mounted on taper plugs or chucks, and the diamond smeared on with the finger. It is run at high speed and used for fine and slow cutting which also gives a high polish.

F. M.

Squaring Numbers

The method shown by Mr. Shaw, at page 539, does not seem as simple to me as one I have used for years, although it is quite possible that this is because I am accustomed to one and not the other. We seem to wear grooves or ruts in our brains until even complicated things seem easy if they follow the old channels. I'm free to admit also that a number of my friends have kindly informed me that my way was the worst ever; but knowing them as I do I attribute their failure to grasp the situation as due to a brain defect; for if it wasn't easy I never could have remembered and used it all these years. Fact is, I inherited it.

Take any number, as 37. Subtract it from the next higher *tens* number, which is 40. This leaves 3. Subtract 3 from 37, giving 34. Multiply 34 by 40, which is easy, getting 1360. Add the square of the difference between 37 and 40, or $3 \times 3 = 9$, and get 1369.

Take 69; subtract from $70 = 1$; $69 - 1 = 68$; $68 \times 70 = 4760$. Square 1, which is 1, and add to 4760, giving 4761 as one square of 69.

In actual practice it doesn't pay to try squaring numbers of more than two figures without pencil and paper, but you can use it just the same. Take 709. Subtract from 710, giving 1. 1 from $709 = 708$. $708 \times 710 = 502{,}680$. Add square of 1, and you have 502,681.

The beauty of my way is (to me, probably the outcome of a lazy streak) that you always multiply by one figure and add a cipher—that's my strong point. Anyone can multiply 34 by 4, and add a cipher, and it's an easy matter to square a single number and put it in place of the cipher.

If you try to forget how long the explanation is and work out a few numbers such as 17, 26, 63, etc., you'll find it comes as natural as quitting when the whistle blows.

F. H. C.

About Core Prints

In the making of castings having cored holes produced by cores supported in horizontal prints, much trouble is caused by prints in which the cores do not fit. If the print is too small, the casting will be likely to show a "crush." In extreme cases, and where the prints form a considerable portion of the mold, the cope may not "close down," thus producing a "fin" at the joint. Or in the case of machine work, with multiple patterns, this will cause the work "to plate," as it is termed. This "plate" is a fin which, by reason of its comparative thickness, bridges across the usually narrow spaces between the many castings in the mold. In either of these cases it is evident that the whole depth of the casting is the thickness of the fin too great.

On the other hand, if the print is too large, the metal will run out into the print, again forming a fin; and if the error be great enough, the metal may run entirely around the core and close the vents, causing the casting to "blow." The core would also be likely to float in the liquid metal, throwing the hole in the casting out of place.

THE VARIATION IN SIZE OF CORES MADE FROM ONE BOX

Now, supposing the cores made from any one box to be always of the same size. Then it would be comparatively easy for the patternmaker to get the prints right. The cores are not always of the same size and it follows that, after the print has been made to fit one size of core, it can be expected to fit but one size.

REQUIREMENTS WHICH PIPE-FITTING CORES MUST MEET

Before this discussion gets too general, let me say that the cores and prints I have in mind are for pipe fittings and goods of that class. The core boxes for the smaller sizes of these goods are usually made of cast iron, and the requirements are that the hole in casting be central, round and of the correct size.

As the machines for tapping fittings use but one tool, a combined reamer and tap, if the hole in the casting is not central it will lead the tap to one side, making the fitting "crooked." If the hole is too large, there won't be a full thread after tapping; and if the hole is too small, it gives an excessive amount of stock, often breaking the smaller sizes of taps.

PLUG GAGES TO INSURE PRESERVATION OF CORE-BOX SIZES

The first point to establish is evidently the size of the hole in the casting. From this the size of the box is determined. This size is preserved, as new boxes are needed, by the use of a solid, or fixed-size, reamer, the size of the reamer being tested from time to time by comparison with a plug gage. As this plug gage is the foundation of the whole system, it is the first thing to be made.

There has recently come into use for this class of castings a variety of core box which it is impossible to ream. This is the multiple box, in using which the cores are rammed up in halves from a mixture

of oil and sand which, when the two half-boxes are turned together, unites the half-cores, thus making the use of paste unnecessary. This is the form of core box alluded to in a former article entitled "A Universal Shrink Rule," on pages 10 to 12 of the current volume; and is one of those cases which "Racquet," on page 222, calls "compound shrinkages."

Friend Racquet is evidently alive to the fact that patternmakers have troubles of their own. Molders are like patternmakers in this respect, and even our English friend will undoubtedly admit that there *are* molders who can produce castings that are accurate copies *reduced by shrinkage* of the pattern used.

The rate of shrinkage which he mentions as in common use in his vicinity, 0.1 inch per foot, is easily reckoned and measured by modern methods, even by ten-thousandths, if necessary. But when the rate is not in decimal parts of an inch, the calculation of the necessary dimensions becomes burdensome.

The Molding Machine Makes for Uniform Castings

For Racquet's good let me say that, after working the pattern to "micrometrical dimensions" by the help of this instrument we have even been able—to a somewhat limited extent, to be sure—to control the molder's manipulation of the pattern. This is done by the use of another "instrument," known as the molding machine.

The molder and the core maker, knowing so well that cores and prints must be made of the same size, had better stop here if they haven't already stopped—as what follows is for patternmakers.

Proportional Calipers for Sizing the Print Gages from the Core Gages

Having the set of reamers and plugs ready for use, we have provided for the core boxes only. The prints are to be sized to match another set of plug gages, which were originated in the following way:

A pair of double-ended calipers was made with knife-edge points, of such proportions that when one end was set to fit the plug gage for a 6-inch core—which, by the way, would measure about 6¼ inches by Racquet's one-tenth "contraction" rule—the other end was 1/32-inch too large for the same gage. As this pair of calipers would register zero at both ends simultaneously, it is plain that whatever amount the shorter end was opened, the other end must always measure a fraction of an inch greater; this variation depending on the size of the opening. They were, in fact, proportional calipers, having a fixed ratio of 6¼ to 6 9/32, or thereabouts.

Did I hear our friend R—— say that this would beat a contraction rule? Yes, but it would take a lot of time to keep both ends in working order, and even then they could be used for but one rate of shrinkage.

These proportional calipers were used to size up the plug gages for core prints, setting the small end to the gage already made for cores, and sizing the print gage by the large end. The two sets of gages made in this way were used for the actual work, and the calipers were laid aside.

When the molder discovers that the core prints are larger than the cores, I expect that he will want them fixed.

Remedying Excessive Size in Prints

There are two ways to fix them, and still leave a little leeway for variation in cores. The first way is to turn the prints, while having a piece of sheet metal between the halves of the pattern, the thickness of the sheet metal to be equal to the difference of opening at the two ends of the proportional calipers. When the prints were finished they were, as aptly described by one whose skill with tools was much greater than his knowledge of English, *"obround,"* measuring the same as the core gage in thickness and like the print gage in width. This method will allow for variation in size of cores, but the cores can vary in thickness in one direction only; they may be smaller than the box, but never any larger.

Perhaps you think that they can't be made *larger* than the box? Well, that's the core maker's business.

It is very evident that if we could avoid a crush, we might do with less clearance; and I think that the following plan will be found effective.

Size the prints—on pattern—by the print gage; and then taper them *down* in lathe set for 1/16 inch taper in diameter per foot of length. If a 6-inch print is 3 inches long this amount of taper would reduce the clearance about one-half, and it would also bring the bearing for the core away from the edge of the mold.

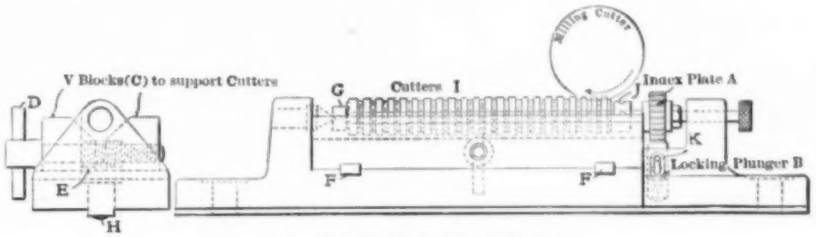
F. W. Barrows.

Jig for Supporting Cutters during Milling

We are manufacturers of a small internal key-seat miller, and this jig was devised to make the cutters as cheaply as possible. These milling cutters are very small, about ¾ inch, and made of high-speed steel, with ¼-inch to ⅜-inch hole through the center. The teeth in these cutters must be milled very accurately, so we are unable to drive the cutters on a mandrel and mill the work between centers without having it well supported.

The sketch shows the jig as it is fixed on the milling machine, with cutters *I* assembled on mandrel *G*. These cutters slip on the mandrel easily, and are tightened by the nut *J*. The teeth in these cutters are finished in one cut, and are firmly supported by the two V-blocks *C*. These V-blocks slide on two keys *F;* this keeps them always parallel, and they are adjusted by the tightening screw *D*. The blocks have a spring between them, so when they are loosened they slide apart by themselves and allow the cutters to be turned to the next tooth freely. These cutters have from 11 to 14 teeth, depending on the size.

Index plates having the same number of slots cut on the edge as there are teeth in the cutters, slip on the mandrel. The locking plunger *B* locks the index plate in the desired position. After milling through the cutters, the table is brought back and the locking plunger is pushed down by the rod *K*, the V-blocks *C* are loosened, the cutters turned to the next notch, and milled through again.



JIG FOR SUPPORTING CUTTERS

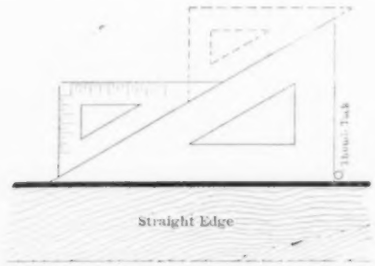
By using this jig, we find that we can turn out three to four times as many cutters in a given time as we have done before, as we mill 20 or more at one setting.

A. C. Pletz.

Jig for Drilling Steam Pump Glands

I hope H. D. Penney didn't think I was such a greenhorn as not to see that my first jig would tilt. My idea was to rest the ends on a piece of waste material when drilling, and I expected a practical man to see that. The greatest objection to the jig shown at 384, in my estimation, is you have to turn it over every time you take the piece in and out. A great deal of time will be wasted by this when drilling a number of pieces. It is held down by a split washer. I have used split washers myself and know how easily they are lost. Don't have a clamping screw loose in the locating stud. It is not mechanical. Have a tight fit of screw and a loose hexagon nut, which is more easily re-

placed. The thickness of web is good in machine design, but I think it is rather too thin for jigs. The way some of them are thrown about absolutely makes your hair curl. The legs certainly avoid contact with chips on the table. You can get the same result in my jig by taking a slight cut with a face mill and leaving a strip at each side. I don't think in this case machining on a machine-steel jig



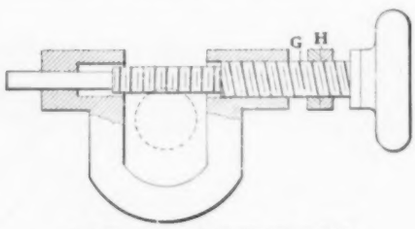
COMBINATION OF TWO SET SQUARES FOR SMALL WORK

would cost as much as patterns, casting, etc., on a cast-iron jig. It doesn't take a milling cutter long to get through machine steel. We all get to the scrap heap eventually. Criticisms make good men, so I trust H. D. Fenney will not be upset by my few remarks. By the way, I send a sketch along which I think explains itself. I found working on small work, like jig work, pushing the square up and down so many times made my arm tired; so I use two set squares, as shown. With one graduated, you can get quite an amount of work out by it. This kink may be known to some, but I have met quite a number of draftsmen who didn't know it until I showed them.

SYD. P.

A Tool that Failed to Work

If Carroll Ashley had made the worm feed of his recessing tool, as shown in the sketch herewith, instead of the way he shows it at page 322, I think the tool



A TOOL THAT FAILED TO WORK

would work all right. The part of the screw *G* that engages with the worm-wheel teeth is like a screw without any lead—that is, a series of grooves of the proper shape and pitch to drive the worm wheel when the screw *G* moves endwise by rotating the hand wheel.

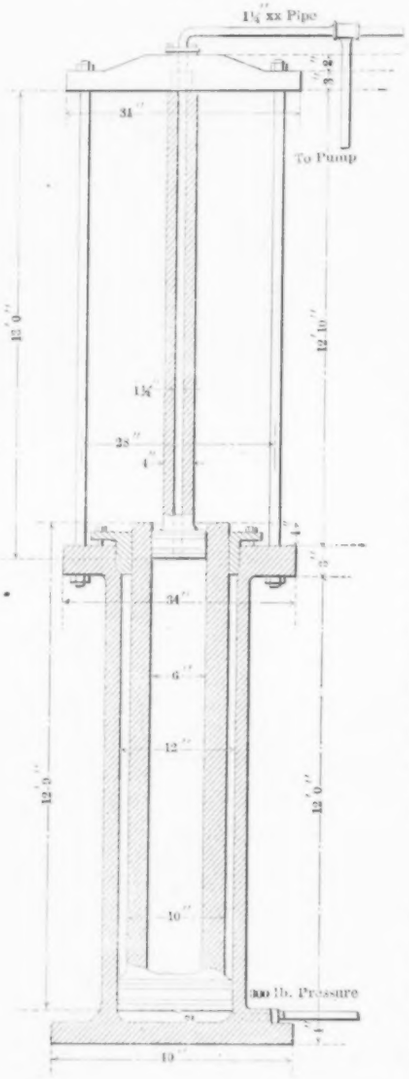
This construction would admit of retaining the nuts *H* as a limit to the outward movement of the cutter, which Mr. Ashley must have sacrificed when he substituted a stationary worm.

Of course, the construction shown here necessitates a longer screw than that in the original device, and perhaps there may not have been sufficient room in which to swing this extra length; but if there was room for it I think it would do the trick.

WALTER GRIBBEN.

Another Pressure-loaded Hydraulic Accumulator

Inclosed is a sketch of a pressure-loaded accumulator which we have used very successfully. We have also used the



A PRESSURE-LOADED HYDRAULIC ACCUMULATOR

same plan with three pistons, but have abandoned these in favor of the two-piston type shown. This figures out with the formula given by J. A. G. Goulet at page 259.

H. F. KILLEAN.

An Unusual Way to "Bush" a Pulley

I suppose that the apprentice boy who hunts for the pan of gas, goes to the tool room for the left-hand monkey wrench, the circular square, etc., is an acquaintance of almost everyone who has worked in the shop. That he is not alone in his amusing errors of inexperience and thoughtlessness, the following incident bears witness. A young man, brought up on a farm, but who at the time had had a considerable shop experience, was one day repairing a machine. He found a pulley belonging to it badly worn in the hole. On going to the foreman for instructions, he was told to "bush" it. He at once went to a nearby clump of bushes and threw the pulley into it. The facts were not long in being discovered, much to the amusement of the entire factory. I can vouch for the authenticity of this story, as I knew both men who were the principals.

I do not know, however, that this young man is any more to be laughed at, in view of their respective opportunities, than the head of a certain large university which has recently established a school of manual training, in connection with which is a small machine shop. This man, who has recently become well and generally unpopularly known through some of his public utterances, assumes to know almost everything and has his own ideas as to the way in which everything should be done. He allows his teaching force but little discretionary power in any way. When the new universal milling machine was set up in readiness for operation, the man in charge of the shop put in an order for the least number of cutters that he thought could be possibly gotten along with. The order was not passed, on the ground that the machine was purchased fully equipped. I have since been told by the man who put in the order that there were just two milling cutters in the shop.

L. A. M.

Consul-General D. F. Wilber, of Singapore, furnishes a newspaper clipping which says that a new shipping company is to be formed in Tokyo, with an approximate capital of $10,000,000. Branches are to be established in Java, Hongkong, Manila, and India. The company is in communication with the Japanese Government upon the question of subsidies, and when this is settled, the matter will go forward at once.

The premium system has invaded the power house and is successfully operated by the Sheboygan (Wis.) Light, Power and Railway Company.

Motor-driven Automatic Turret Lathe

A Machine Using Automatically Controlled Variable-speed Motors for Operating the Spindle and Cam Drum Shaft at Any Desired Speed

BY D. H. PARKER

At page 1624, Vol. 27, Part 2, the AMERICAN MACHINIST illustrated the Gridley automatic turret lathe built by the Windsor Machine Company, Windsor, Vt. Some illustrations are here presented of a new form of this machine in which both the work spindle and cam drum shaft are driven by variable-speed motors the controllers of which are operated automatically by cams on one of the drums, this arrangement giving a very flexible control of cutting speeds and feeds throughout the cycle of operations required to produce any given piece of work.

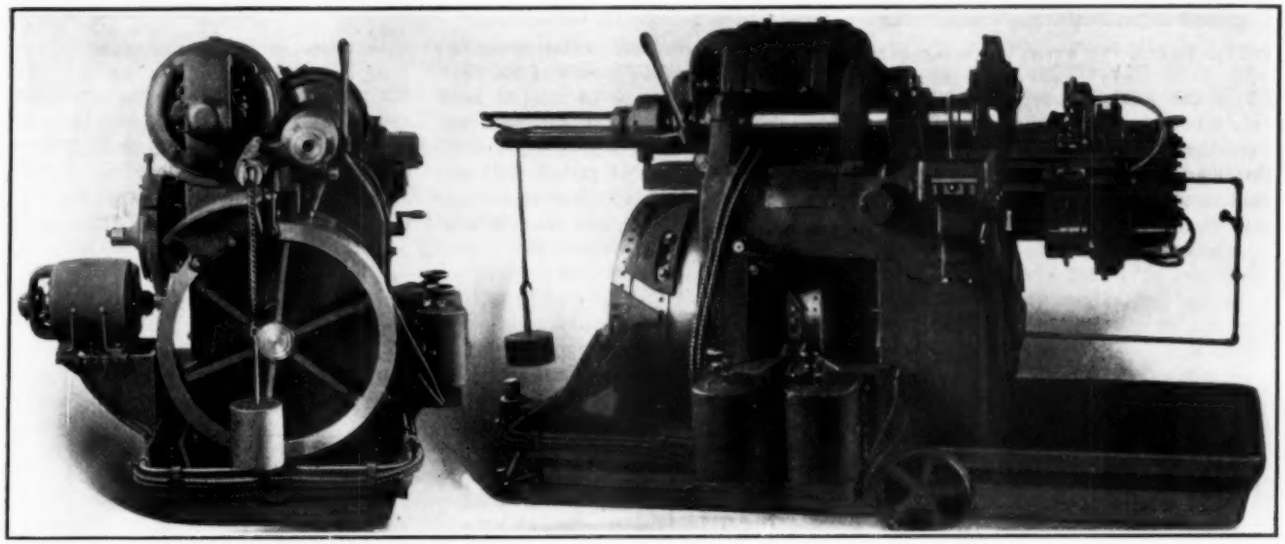


FIG. 1. FRONT AND END VIEWS OF AUTOMATIC TURRET LATHE

THE SPINDLE DRIVE

This type of motor-driven machine is made in two sizes, one taking bar work up to 3¼ inches, and the other up to 4¼ inches diameter. Front and end views of one of the machines are shown in Fig. 1 and a general view from the rear in Fig. 2. The variable-speed motor for the spindle is mounted as represented in these engravings, at the top of the headstock and behind the spindle, the head itself with the motor removed, being shown clearly in Fig. 3. The motor is a General Electric 3-horse-power machine geared 10 to 1 to the spindle, a sectional view through which is given in Fig. 4.

CAM-SHAFT DRIVE AND MOTOR CONTROL

The variable-speed motor operating the drum shaft and the turret-revolving mechanism is fixed to a bracket which is attached to the oil pan, and the rear column of the machine, as shown in Fig. 2. Both motors are operated by controllers placed near the floor at the front side of the machine. The metal tubing incasing the armature and field wires from the spindle motor to its controller is shown in Fig. 1, while in the rear view the wires from the feed motor to its controller are seen following the top of the oil pan. The controllers themselves are operated automatically by a small gear beneath the controller handle meshing with a segment gear pivoted on the frame holding the controllers, the segment gear being moved as desired by cams bolted to the operating drum. Fig. 5 shows this, the controller handles being removed. By using different cams any desired speed may be obtained for the spindle motor, or it may be entirely stopped while the tools are withdrawn from finished work.

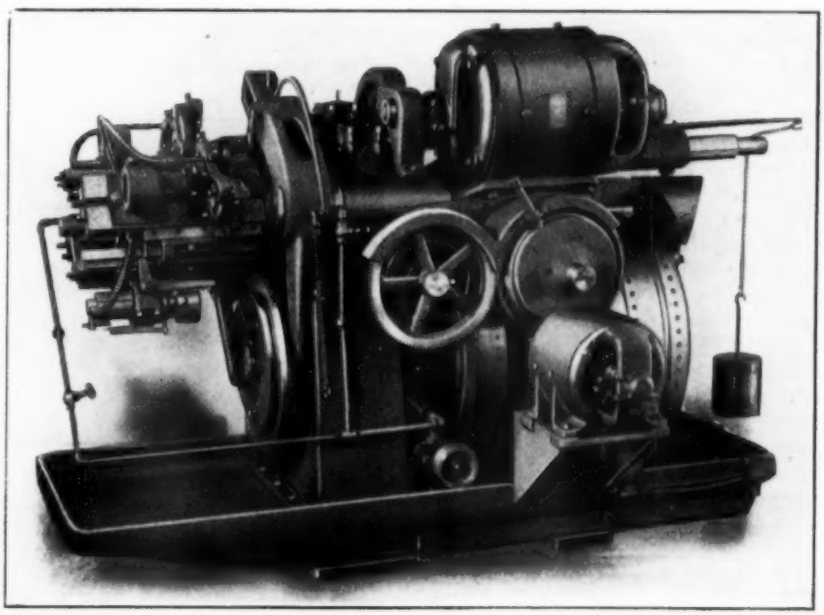


FIG. 2. REAR VIEW OF AUTOMATIC TURRET LATHE

Speed and Feed Variation

In threading work, inside and out, advantage is gained by slowing the spindle motor to the proper threading speed, and then reversing at full speed for backing

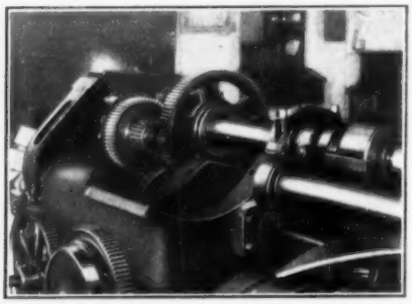


FIG. 3. HEADSTOCK WITH MOTOR REMOVED

off or out solid dies or taps. This not only saves considerable time, but by having the proper cutting speeds better threads are obtained. The variable-speed feed motor in combination with the four sets of feed cams in the machine equipment gives the proper range of feeds, from that required in drilling tool steel to the coarsest roughing cut a ½x1-inch high-speed roughing tool flooded with oil will stand. The wide range in both speeds and feeds instantly obtainable for every operation, with also a variable reverse speed of the spindle, enable the machine to handle to advantage any work within its capacity. The fast and slow motion for the drum shaft is obtained by driving the worm direct from the feed-shaft motor or back geared through planetary gears, operated by the same cams as are used on the belt-driven machines for this purpose.

Turret Tools

Figs. 1 and 2 show some of the tools used on this type of machine, and also the method of attaching them to the slides which are operated to and fro in the guides in the turret faces. For taking heavy cuts, roller-back rests are used with the turners, which give the work a highly burnished surface; finishing cuts are taken, however, with plain back rests. For high-speed drilling operations the attachment shown in Fig. 6 is utilized. At the front of the head a bracket is secured carrying a hollow spindle driven at high speed by gearing from the main spindle, and on one of the turret slides is secured a head carrying a driving shaft which is adapted to enter and be driven by the hollow spindle. The driven shaft is geared to the drill spindle below, imparting to it a high rate of speed.

High-speed Drilling

A statement of some actual operations recently performed by means of the drilling attachment may be of interest here. In making some small bushings 17/16 inches long of cold-rolled steel, a 9/16-inch Morse oil drill of carbon steel was used. The work spindle was run at 180 revolutions per minute, and the drill spindle driven at 1200 revolutions, the cutting speed being slightly over 200 feet per minute, and the feed 0.0025 inch per turn. Oil was forced through the drill at about 20 pounds pressure, and the machine ran two days with one grinding of the drill.

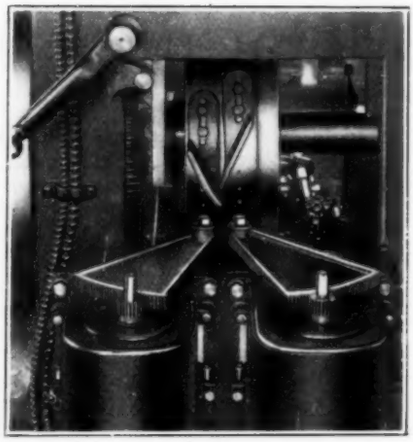


FIG. 5. THE CONTROLLERS

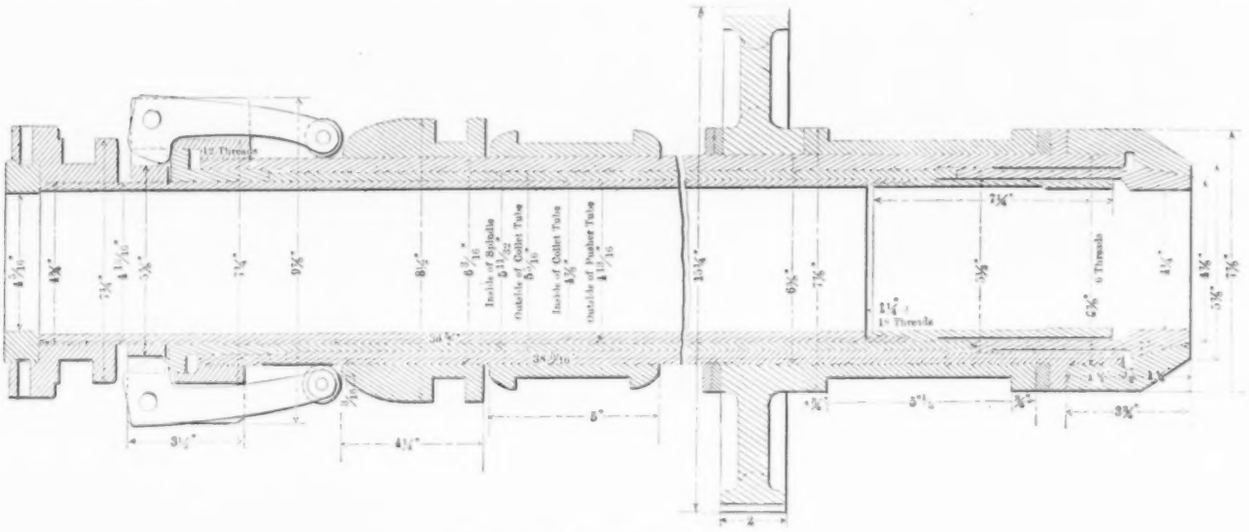


FIG. 4. SECTION THROUGH SPINDLE

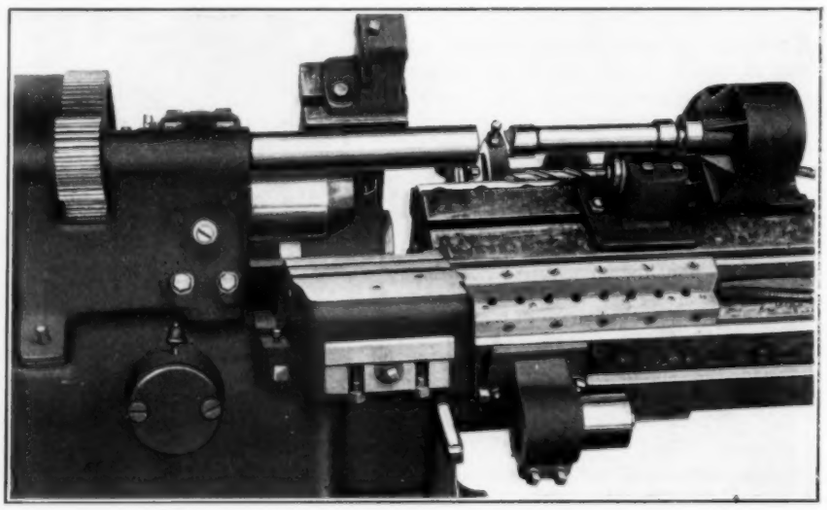


FIG. 6. HIGH-SPEED DRILLING ATTACHMENT

A 1-inch drill of the same kind was then used with equal satisfaction in some bushings 5 inches long with the spindle running at 180 and the drill spindle at 300 turns per minute, giving a cutting speed of 125 feet per minute, the feed being 0.005 inch per revolution, or about 2½ inches per minute.

Trade Schools

By Tech

Entropy, at page 239, hits the nail fairly on the head. Manual training, as it is ordinarily taught, is about as different from trade training as a piece of pyrography is from a well-made pattern. Seriously, manual training is nothing more than advanced kindergarten work. It is meant to train the hands, is intended for cultural training only, and is not intended to give skill or information in trade processes. Some of the trade operations have been taken, distorted in many cases, and used, but there the connection stops.

Many of the teachers of manual training are professional teachers, trained as such, and do not pretend to be mechanics in any sense of the word; in fact, many of them would resent being called mechanics, or to have it implied that they had ever done such degrading (?) work. I think you will find, on the other hand, that the best teachers of shop work are men who object to being known as teachers, but prefer to be known by what they can do or have done in practical work.

It may seem strange to many, but educational institutions seem to be influenced by precedent more than anything else. The question in most cases seems to be, not what should be done, but what is someone else doing? Manual training has been a good example of this. Years ago the Commercial Club, of Chicago, started the Chicago Manual Training School, because they said the ordinary high-school course was not what a boy needed to start him in business or to earn his living. Educators naturally did not take kindly to the proposition of mere business men telling them what they should do, but the school was started just the same. When this school opened the men in charge of the shops were good mechanics, and were paid salaries high enough to make it worth their while to do the work. The manual training idea "took," and the educators who before had criticized were compelled to do likewise; but unfortunately they looked upon the men whom they wanted to teach manual training in the same light that they did the other teachers, that is, as though teaching were the only thing they could do; and the salaries were in proportion. These educators could not then, and do not now, realize that a man who has the proper training to fit him for this work is in demand in the manufacturing world as well as in the school; and that a salary that looks big to a man who has just graduated from college and wants to teach Latin, looks mighty small to the man who can hold down any sort of a job in the shops. If a man were to advertise for a foreman for a first-class machine shop at a salary of $800 per year, would you want to trust any kind of a shop to the care of the men who would apply? And yet to teach shop work the way it should be taught, certainly requires a man with at least equal ability.

Work as carried on in some night classes in various parts of the country would seem to be a close approach to the proper manner of handling trade classes. The progress in this line of instruction has been brought about to a great extent by the men in the classes, as they are old enough and intelligent enough to know what they need; and if they don't get it either they stop coming or the class instruction is altered to meet their needs. There is also another reason for the variety of work done in these classes. The instructors are more apt to be men of practical experience, as of course, this work being done after working hours, a man is not dependent for his living upon his salary as an instructor.

Another thing: the subjects taught in a trade school should not be taught in the same manner as they would be even in an engineering school. For instance, a machinist should know something about trigonometry, for it is a mighty convenient thing on lots of spiral milling jobs and work of that character; but it is not necessary for him to take a complete course in trigonometry in order to find sines and tangents in a table and use them intelligently. One hour per day for two weeks would be all the time needed for instruction and practice. A professor of mathematics would hold up his hands in holy horror at this, but I know where this is being done in even less time.

To carry out the idea, all the meat of an engineering course, so far as the trade student is concerned, should be boiled down and given to the trade-school boy with the froth taken off. Many of the subjects now taught in the engineering schools could be cleared of their befogging mathematics and taught with advantage in a school of this kind. It will take the best sort of a man to do it, but it can be done. Mathematics should be taught, for instance, by a man who is himself a thorough mechanic and understands just how it is used in the shops; and the same holds good for all the studies right down the line. The shop must not be treated as distinct from the classroom, but the two must run together. This will hardly fall in with the ideas of the old professor of mathematics, who said that he wished mathematics was of no practical use to anybody and never would be.

I studied trigonometry under a man who was as good a teacher of pure mathematics as it has ever been my good fortune to run across, but the whole thing impressed me as being a glorious sort of ingenious puzzle and of no particular practical value. Several years after, when problems came up that could not be straightened out without trigonometry, I thought what a splendid chance that man had missed to teach us boys something really good.

There is no question that schools of this sort are to a large extent in the hands of professional educators, and, even if they could obtain the right sort of men, a Ph. D. after a man's name carries far more weight than any amount of successful practical work along engineering or mechanical lines. As an example of how schools are administered, in the catalogs of several technical schools you will see that forge work and foundry work are taught by the same man. How many good blacksmiths are there who know what grades of iron to mix in order to obtain castings of a certain hardness? Or how many molders do you know whom you would trust to temper a milling cutter?

I know of the heads of several technical institutions that were not in the remotest way connected with engineering or mechanical work until they took charge of the institutions in question. These men are educated, intelligent men, but they know absolutely nothing about the work their schools are supposed to teach; and to hear them talk you cannot but be impressed with the fact that, while they consider it a very serious thing to make any mistake in the exact amount of credit to be allowed for a certain course in English, they are not particularly interested in the shop and practical work. I heard a man of this kind remark that after he had tried a practical man as teacher in one of his shops and he was a failure, he had filled his place with a man who was not a mechanic, and things had gone splendidly. I knew of the facts in the case, and they were about as follows: the practical man was a man who was about as profane and vile a talker as I ever had the misfortune to listen to; he did not seem to care particularly about his work, and was not the sort of a man adapted to teaching anything. The man who took his place had had considerable experience in shops of various sorts, had a technical education, and was working as a draftsman when he accepted the position as teacher. He took the place because he thought it would give him time to do some experimenting. Now do you think the educator's remark was fair?

The American Machinist has done much in the past for the cause of trade schools and I, for one, hope it will keep the good work up. Ten years' experience in night work of this sort has shown the crying need for the trade school and it is bound to come. The men want it, the employers want it, and it is up to the school men to give it, and if Massachusetts will start the thing as it should be

started, it will be a big step in the right direction, but "here's hopin'" that they won't put a man in charge like Dixie's professor of "practical" mathematics who had to square the two sides of the bed to see if he could lie cornerwise.

One word about books: I don't think Entropy means all he seems to say, for certainly there have been many books written that have been a help in the right direction. He certainly indorses the AMERICAN MACHINIST, which is nothing if not a continued treatise on mechanical construction.

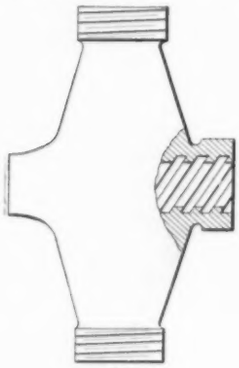


FIG. 1

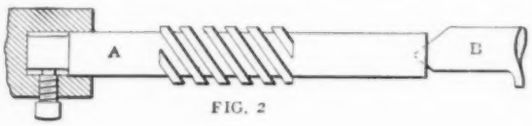


FIG. 2

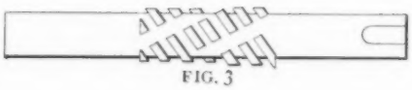


FIG. 3

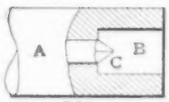


FIG. 4

FIG. 5

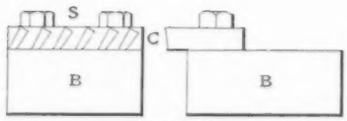


FIG. 6

THE VALVE BODY, STEM, TAP AND OTHER TOOLS

Tapping a Fast Thread by Hand

An interesting job of tapping valve bodies with a sextuple thread 1½ inches pitch was handled in a very neat way by Elmer Eberhardt, of Eberhardt Brothers Machine Company, Newark, N. J., some time ago. The object of this thread is to allow the stem to unscrew enough to prevent binding when the valve body contracts in cold weather. Whether it works out in practice or does not affect the methods used.

The parts came all finished except the threading, and this came so near being a worm-gear job that the maker picked out Eberhardt Brothers on account of their being specialists in this line.

The valve body is shown in Fig. 1, which shows how nearly this tapping comes to a broaching job. The stems were driven by the chuck at *A*, Fig. 2, the stem centering by fitting the mouth of the chuck and the set-screw holding on the square end of the stem. The dead center was cut away at *B* for the same reason as in milling-machine work, to allow the chaser plenty of room beyond the end of the stem.

CORRECTING THE CENTER

Some of the stems were not centered quite true when received, so the little device shown in Fig. 4 was made. The end of the stem just fits at *B*, and the cutter *C* corrects the center in line with the outside of the stem.

A good idea of how fast this thread is for such a small diameter as ⅞ inch can be had from the point of the tool used to chase the thread of the tap. See Fig. 5. Next to it is the chaser used for cutting the threads on the stem, and the teeth naturally have the same angle. The cutter *C*, Fig. 6, is fastened to a cast-iron block *B* by cap screw *S*, the complete chaser being clamped to the tool block of the carriage, the lathe geared for a pitch of 1½ inches, and a few passes of the tool finishes the thread.

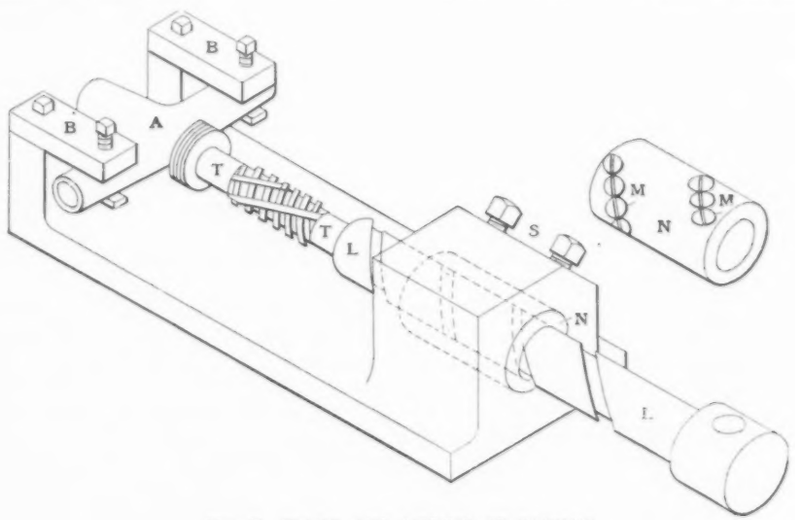


FIG. 7. FRAME AND METHOD OF TAPPING

TAPPING THE HOLE

Tapping a ⅞-inch hole with a square thread of this pitch is a different proposition from ordinary tapping and requires something to give it the right lead while cutting the thread, so the tapping frame shown in Fig. 7 was devised.

The valve body *A* was held loosely by clamps *B B*, while the business end of the machine carried the lead screw *L L*, cut with a single thread of the right pitch. This runs through a bushing or nut *N*, having a babbitt thread for guiding.

This bushing was simply a cast-iron sleeve on which a thread of the right pitch was marked as a guide, and having holes *M M* drilled along this thread. These holes were then filled with babbitt, poured around lead screw *L L*, making the thread of the nut but leaving the cast iron as a bearing and guiding surface for it. The bushing was held by set-screws *S*, so as to be easily removable, as this was only used for the first tap. The second tap needs no guide but the thread already partly cut, and the plain bushing does away with the care that would be necessary to start the second tap in the thread.

THE TAPS USED

The tap is shown roughly in Fig. 3, but it is hard to make a line sketch that gives a really good idea of it, on account of the grooves being cut spirally so as to be at right angles to the thread and give square cutting edges; and the camera wouldn't show it big enough.

The roughing tap was almost a broach, the front teeth taking a very light cut and the following teeth each taking out a little more, so that very little is left for the finishing or sizing tap.

As will be seen, they were tapped by hand with a bar through the outer end of *L*, and a single turn comes pretty near putting the tap through as far as necessary.

Several hundred were made in this way and the methods used ought to contain hints that can be used in other work where fast threads are employed.

Among the recent inquiries received for machinery for South Africa have been confectionery-making equipment for Port Elizabeth and oil-mill machinery for Pretoria.

Industrial Education in Public Schools*

By J. Ernest G. Yalden

It seems to be generally conceded that some kind of industrial training is not only desirable but necessary; but it is by no means conceded what kind of industrial training is the best to prepare those of our youth who are ultimately to follow industrial pursuits.

The Superintendent of Schools of New York City in his seventh annual report, speaking of the economic necessity for free public trade schools, says: "Even if, however, manual training should produce all the results its advocates claim for it, there is still an urgent necessity for the trade school proper. But as to what is the best kind of trade school, what is the best course of study for such an institution, what is the best method of administering it, we are all profoundly ignorant."

The Douglas Commission of Massachusetts states that out of 2437 manual-training students, only 52, or 2.1 per cent., are found in mechanical trades.

To meet the requirements of training for the different classes of industrial workers, schools of various types must be established.

These schools might be generally classed as primary and secondary industrial schools.

The primary industrial school should provide a training in as short a time as possible to enable our youth to enter industrial pursuits as efficient helpers and ultimately to become mechanics.

The secondary industrial school should provide a training for those who are qualified by natural ability and previous training to ultimately advance beyond the grade of mechanic to that of foreman or shop superintendent.

In my opinion this classification of industrial schools should be closely followed.

While certain of our youth should be given an opportunity to acquire the training necessary to fit them to advance beyond the grade of mechanics, it is by no means necessary to assume that it is wise for all to have such a training.

While this may be of the nature of a class distinction, it is a distinction based not necessarily upon economic circumstances, but upon natural capacity and fitness.

As we do recognize it to be the duty of the State to give educational opportunities to all, we must consider those who for various reasons do not, and cannot, attend these manual-training schools, and offer to them an equivalent better adapted to their needs.

I refer particularly to the large number of youth who are compelled to leave our elementary schools to go into unskilled work and who do not always have the mental capacity for further educational work, but do possess the ability and often the desire, to become mechanics.

If the State is to establish a system of industrial training, the following underlying fundamental principles should be carefully considered:

1. Day classes for primary industrial schools.

2. Evening classes for secondary industrial schools.

3. Greater importance and need for the primary industrial school.

I shall only attempt at this time to discuss the question of the primary industrial school, as it is the type to which little attention has been paid by educators. It is the most important as being the first step in a logical system of industrial training, and owing to the fact that such schools will offer opportunities for advancement to that larger number of our youth for which practically nothing is done at the present time.

As to the type of primary industrial school, I wish to strongly advocate what may be termed the short-course day class.

As this view is apparently at variance with that of the majority of educators, I will attempt to explain and defend my position as logically as possible.

To more fully explain the difference between the short and long course ideas in industrial training, I will briefly define them.

The short course is to provide a carefully selected number with a training sufficient to enable them to secure employment in the skilled industries as beginners or helpers.

Under this plan it is assumed that experience gained by working at a trade is the principal requirement to insure advancement to the grade of mechanic or journeyman, rather than a longer previous industrial training.

This training to be given only to those of an age possessing the physical ability and sense of responsibility required of such a class of labor.

On the other hand, the long-course idea is an attempt on the part of educators to utilize the so-called "wasted years" of the child's life, by inducing them to remain at school until they are old enough to be physically fit to enter skilled industries as beginners or helpers.

The training of course is intended for that very large number who leave our schools between 14 and 15 years of age, and are engaged is the so-called unskilled occupations.

The main objections urged against the short-course idea are primarily its inefficiency, and secondarily the attitude of the unions.

While the fact is to be regretted that a very large number of our youth devoted the "wasted years" of their life to unskilled labor, rather than schooling, yet it cannot be denied that they gain some advantages thereby.

It develops a sense of responsibility among the more capable, and a most earnest desire to change their unskilled vocation for a skilled one with its higher reward.

Such youth in a very short time realize the limitations of their position in life, and are therefore much better fitted to appreciate and benefit by any opportunity offered to improve that condition.

That the short-course trade school has offered this opportunity cannot be denied in the case of the Baron de Hirsch Trade School; I should like to present the following evidence to substantiate this fact:

Quoting from my report to the Baron de Hirsch Fund for 1904:

Wages Received Before Entrance to the School Compared With Those Wages Received Immediately After Graduation

"It is interesting to learn what our graduates can earn immediately after completing their 5½ months' course in the different trades, compared with what the same cases could earn at the various occupations in which they were employed before entrance to the school; and so ascertain the improvement in wage-earning capacity due to the preparation we give them to enter the mechanical trades.

Of the 351 graduates of the fifteenth, sixteenth, seventeenth and eighteenth classes, 190 have reported their occupation and wages at time of entrance to the school, and their occupation and wages immediately after graduation.

The average of these results shows that the wages paid to young men in New York City who are employed in the different occupations open to them without any previous training or preparation, is $5.39 per week; their average age being about 17½ years.

After receiving a 5½ months' course as a special preparation to enter mechanical trades, these same young men can earn $7.54 per week, or a gain of $2.15, due to their change of occupation made possible by our course of instruction."

I have within a few months made a similar investigation of 242 of our graduates. An average gain of $1.47 per week was shown.

From what I have said, and by virtue of what has already been accomplished, I believe I am fully justified in recommending the establishment of a short-course primary industrial school, as an attempt to solve the problem and meet a present demand on the part of certain of our youth.

*Abstract of an address given before the Connecticut Teachers' Association.

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Building Ships for the Government

Charles M. Schwab, president of the Bethlehem Steel Corporation, which owns the Union Iron Works, of San Francisco, the Eastern Shipbuilding Company, of New London, the Crescent Shipyard Corporation, of Elizabethport, and other important shipbuilding establishments, announced recently at the annual meeting of the corporation which he heads, that the company would take no more shipbuilding contracts from the United States Government; but that, upon the completion of the several war vessels now under construction by the corporation the facilities of the various yards which it controls would be devoted exclusively to the building of merchant vessels.

According to Mr. Schwab the building of naval vessels is carried on in this country at a loss, and he states that at the Union Iron Works, where three warships are now under construction, nearly $2,000,000 loss was charged off in the past year. Part of this loss was due to the San Francisco earthquake, which overthrew derricks, damaged docks, etc., while another factor was the changed condition in trade since the contracts were taken, several years ago, when wages and materials were lower. But the main cause of loss on such work, Mr. Schwab explained, is the delay due to government authorities who by changes in specifications on the work under way and by certain inspection methods hamper the shipbuilder's progress.

While the published accounts of Mr. Schwab's remarks do not state just what methods of inspection as followed by the officials cause expensive delays in the carrying out of contracts on vessels, it is well known that in different lines of manufacture for the Government there are not infrequently vexatious and more or less costly hindrances due to over-officious and finical inspectors. Yet, on the other hand, there have been not a few instances where a still more critical inspection upon the part of the authorities would have been advantageous ultimately to the Government and the reputation at least of the contractor.

As regards the changing of specifications during the construction of work on battleships, cruisers, and other naval vessels, there is undoubtedly much cause for complaint upon the part of the companies building such ships. Where contracts are placed as they usually are in this country for a man-of-war to be completed in three, four or five years, during this long period of time many modifications of the original design naturally appear desirable to the authorities who are constantly studying the recent constructions of foreign shipyards, yet any attempt to incorporate alterations in a vessel well under way, whether in the way of heavier armor, more powerful armament or higher-powered machinery means of course more or less delay in the work with additional expense to the builders for which they cannot well be entirely compensated.

While it is desirable from every point of view that our war vessels, if we are to maintain a navy at all, should be of the highest order in all respects and that those responsible for the design of these vessels should see that all features of merit are included in their construction, there ought to be some means devised by which up-to-date plans may be laid down, followed out consistently, and the ship commissioned before it has become obsolete. Well authenticated instances are on record where some comparatively unimportant detail of a vessel under construction has been considered and reconsidered by the different authorities concerned, and considerable valuable time lost before some compromise could be effected, and the work of construction proceeded with. Much of the delay in certain cases is naturally ascribed to the "red tape" which has to be unwound in the transaction of business in governmental departments.

Some foreign nations, and particularly Great Britain, seem to be able to commission a powerful man-of-war of the most modern construction in two years or less from the date of commencement of operations, with the result that the vessel has a number of years' service ahead of her before she need be relegated to the scrap heap as an obsolete craft. While Great Britain is adding to her fleet 23-knot vessels we are completing as our latest and most powerful battleships 18- and 19-knot vessels which, while they were considered the very highest examples of the naval constructor's art at the time their keels were laid, several years back, can hardly be called such today, when compared with the "Dreadnaught" class, produced in British yards, or with the 19,000-ton "Satsuma," and her sister vessel, now building in Japan. Moreover, we have still in process of building battleships which are not of the class of the 18-knot "Connecticut," but which when eventually finished will have a speed of 17 knots or less. Such, for example, are the sister ships "Mississippi" and "Idaho," whose keels were laid early in 1904, and which have a displacement of 3000 tons less than the "Connecticut," and engines rated at 6500-horse-power under those installed in that vessel.

When the "Louisiana" was building at Newport News, and the "Connecticut" at the New York navy yard, considerable attention was focussed upon the competition between the private shipbuilding concern and the Government yard which were erecting these sister vessels, and upon their completion it was quite generally believed that the Government would not undertake the construction in navy yards of further men-of-war, as it was

found that the "Louisiana" was finished somewhat ahead of the other vessel, and also at a somewhat lower cost. Considering the fact that no such ship as the "Connecticut," or, in fact, any first-class battleship, had previously been built in the New York yard, and that much equipment had to be laid down especially for the work, the showing made was an exceedingly creditable one. It is possible that if other great corporations follow the example of Mr. Schwab's concern, and refuse to accept government contracts for vessels, the navy yards, after all, may be found to be pretty good places for the construction of future warships; and it is also possible that with thoroughly up-to-date equipment, and with considerable work of similar character undergoing operations at the same time, the cost of government-built ships may not be much higher than that of privately constructed vessels of the same type.

The American Museum of Security —Meeting of the Advisory Committee

A meeting of the advisory committee of the American Museum of Security was held after a pleasing dinner at the Aldine Association on the evening of April 11.

Dr. Josiah Strong called the meeting to order, and Dr. William H. Tolman read a letter from Francis H. Richards, offering a gold medal to be awarded for the best invention presented at the first exhibition of the museum, relating to automobiles and motor boats.

The committee then organized, with the election of Charles Kirchoff as chairman, and T. C. Martin as vice-chairman. The question of the gold medal offered by the *Scientific American* was discussed, and a resolution voted that a committee of nine be appointed by the executive committee to award this medal, having full power to limit the field of award and establish such conditions as seem necessary. Three new members are to be appointed to this committee each year, taking the places of three who will retire.

It was then voted that a similar committee of three be appointed to award the Richards gold medal.

Dr. Tolman announced that Dr. L. L. Seaman has offered an annual prize of $100 for the best essay on the subject of Safeguarding Life, intending that the essay shall be a study of existing conditions and methods for their improvement. It was voted that a committee of three be appointed by the executive committee to award this prize.

An informal discussion of the work of the museum occupied the remainder of the meeting, the desire being expressed that industrial associations become interested in the work.

United States and German Tariff Relations

Some little time ago reference was made in these columns to our tariff relations with Germany, and especially to Secretary Root's statement to the House that no agreement had been reached between that country and our Government since the temporary understanding established last year and at that time brought to the attention of Congress. The matter as then left meant that in the event of there being no further arrangement made in the meanwhile the maximum tariff would be applied to our goods imported into Germany on and after June 30 of the present year. It is of interest to note in this connection that a new temporary understanding has been reached with Germany, which upon its ratification by the Reichstag may form a basis for a more lasting trade agreement between the two governments, provided our Congrees sees fit to accept this further opportunity for a reciprocal compact. While the full details of the new proposition have not as yet been announced, it is not generally supposed that they are of an exacting or extreme nature.

Ambassador Tower at a banquet recently held in this city spoke on this subject of trade relations between our country and Germany. He stated that during the five years he had been located in Berlin he had seen a decided growth in the friendship between the two nations, and then explained how, under the most favored nation clause, the United States has had the benefit of tariff concessions accorded to various European countries, and that now reciprocity treaties have been negotiated by Germany with those countries making it necessary for us to enact a similar treaty or lose the trade advantages we have heretofore enjoyed. Our exports to Germany amount to nearly $350,000,000 annualiy, and these will come under the general and not the treaty tariff of that country unless our Congress decides to take favorable action in the matter and enter into a reciprocal arrangement.

Mr. Tower referred also to the work of the special tariff commission sent to Germany some time ago, which is headed by Dr. North, director of the Census Bureau, and whose report, now in the hands of the President, will doubtless be made public in the near future.

In connection with the foregoing matters he touched upon American business methods as viewed by Germany and said:

"American business methods are fully appreciated and highly thought of in Germany. They have penetrated in many directions into the increasing volume of Germany's trades. Much that we have developed in the rapidity of transacting affairs and the facility with which we dispose of questions that arise has found its way into Germany. It is very likely indeed that if you were to ask a German merchant what he would prefer for his son in order to equip him for the career upon which he is about to enter, he would say, 'A year or two in an American counting house.'"

The National Export Association of American Manufacturers

A new indication of the efforts which American manufacturers are making to obtain an entry into foreign markets is the formation of the above association, with offices in the Park Row building, of this city. The object of the association is to establish an office in Paris, and ultimately in other European cities, and thus provide for the gathering of trade information, for the consignment of stocks of goods and for making provision for such consignments in the neutral free port of Hamburg, together with the investigation of credits and the provision of better banking facilities than American manufacturers now enjoy in foreign countries.

The president of the association is William A. Harris, of the William A. Harris Steam Engine Company, and the treasurer is Elam Ward Olney, of the Red Cross Powder Company, of New York.

The Carnegie Dedications

These be great days for Andrew Carnegie. As we go to press, the news of the opening ceremonies of the dedication of the Carnegie Institute at Pittsburg, reaches us. The current week witnesses the corresponding ceremonies in connection with the Carnegie Engineering Building, of this city, and next week will see the house-warming of the new building of the Engineers' Club.

It has been given to few men to be able, and to no other man to be willing, to distribute wealth for the public good in the manner in which Mr. Carnegie has set an example for the world. It is certainly worth while to be able to do such things and royally has Mr. Carnegie grasped his opportunity.

A unique feature of the dedications is the presence of foreign guests of Mr. Carnegie to the number of 25. It is understood that these gentlemen have been asked to visit this country at Mr. Carnegie's expense to see all that they wish, and to stay as long as they can.

Mr. Carnegie's Pittsburg benefaction, as now rounded out, comprises a library, art gallery, museum, hall of music and technical school, all of which are already in operation, the latter with over 1500 students.

The New York surface car lines, with electric conductor in conduit below steel level, cost $150,000 per mile.

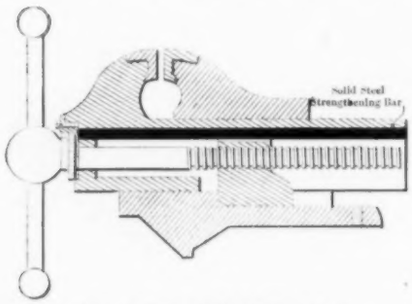
New Tools and Machine Shop Appliances

Showing the Progressive Development of Modern Shop Equipment and the Progress of Design in This Department of Work

THE LATEST INFORMATION

A Vise with Reinforced Slide

The illustration shows a sectional view of a bench vise having a steel strengthening bar incorporated in the top of the slide just where it will do the most good. These bars vary in width from ⅜ to ¾ inch, and are ⅝ inch thick. They run the

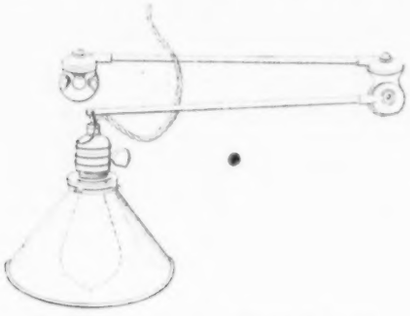


A VISE WITH REINFORCED SLIDE

entire length of the slide. The bodies of the vises are made of semi-steel. The steel faces of the vise jaws are detachable, and when worn can be readily replaced. These vises are made by the Charles Parker Company, Meriden, Conn.

Adjustable Electric-light Fixture

This fixture is adjustable in every direction through the medium of four pairs of friction disks. The wall bracket is a solid casting and carries two circular friction disks at right angles to each other, one disk being screwed to the wall or



ADJUSTABLE ELECTRIC-LIGHT FIXTURE

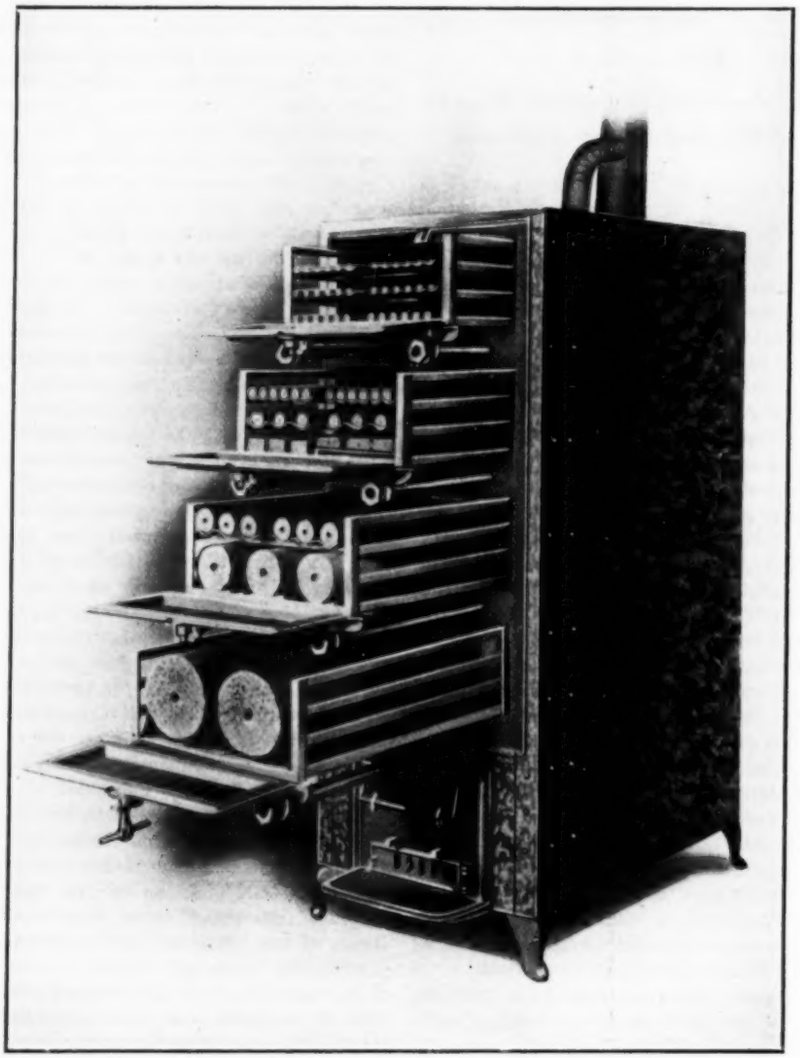
ceiling and the other carrying the first arm of the bracket which has a horizontal movement.

Connecting this with the arm carrying the lamp itself is another pair of disks also at right angles so that the combination gives a universal movement. The large friction surfaces give it a rigidity that is too often lacking in fixtures of this kind and as a fiber washer is used between each pair of disks, the durability is assured. It is made by A. B. Christman, Springfield, O

A Portable Core Oven

Many attempts have been made to design an economical and at the same time efficient portable core oven. Most cores are baked in heavy brick structures, which take up an unduly large amount of space, and which cannot be moved or shifted as development in the department requires more space or a change in the general arrangement of the plant.

The accompanying illustration represents a self-contained drawer oven, the one shown being equipped with four drawers, supported by rollers at the back and by pipe guides at the front. The drawers are removed from the oven by slipping a pair of handles into the pipes shown in the front, lifting them slightly and running them forward by means of the wheels on the inside at the back of the shelves, the action being much like that of a wheelbarrow. The shelves are self-sealing, in that when they are drawn forward a plate closes the opening, so that the baking of the cores on the other shelves goes on without interruption. In the illustration the shelves are shown open and drawn to different distances, so



PORTABLE CORE OVEN

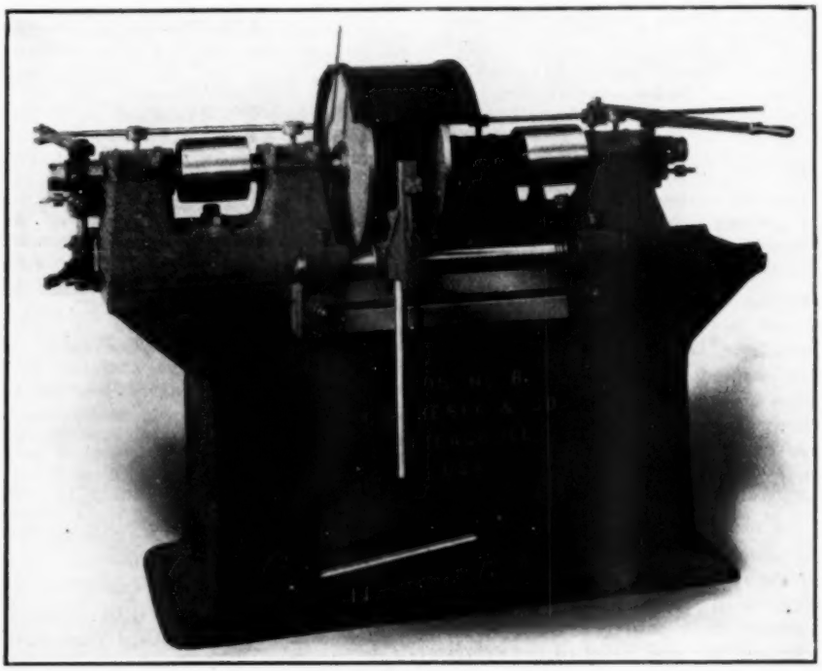
as to illustrate the variety of cores which can be baked in an oven at one time. The large cores on the lower shelf are 7 inches in diameter. The fact that the fronts of the doors drop down, as shown, enables the core plates to be taken out easily.

These ovens can be distributed about the core department, thus minimizing the distance the coremakers have to walk to put their cores in the oven, and a rearrangement of the department can be effected very easily, as the portable oven is no more difficult to move than the core bench.

In an experimental run the temperature was found to be 450 degrees in practically all parts of the oven, and this temperature was easily maintained the entire day on one bucketful of fine coke or breeze, swept up in the coke bin.

One point in this oven to which especial attention should be called is the provision for supplementary shelves dividing the main drawers into divisions. As shown in the illustration, the two highest drawers are divided into three shelves each, the next into two and the bottom one is arranged without any supplementary shelves. The facility with which these different divisions can be put in will enable the operator to dry any size of cores readily.

This device was designed by George H. Wadsworth, of Cuyahoga Falls, Ohio, and is manufactured by the Falls Rivet and Machine Co., Cuyahoga Falls, Ohio, U. S. A.



DOUBLE-HEAD DISK GRINDER

Double-head Spiral Disk Grinder

In the double-head disk grinder shown herewith the heads are mounted on V's planed on the bed casting, and clamped in position, similar to the tailstock of a lathe. Both spindles have about one inch longitudinal feed in the heads, to bring the disk wheels in contact with the work. This movement is actuated by hand lever and foot lever, through gear and rack on each outer bearing bushing, and is limited by micrometer stop screws, as shown. The spindles are geared together by means of the connecting rod shown at the back of the machine, so their movement to and from the work is simultaneous and uniform.

The work rest has a rocking motion, with fine end adjustment for centering it between the disk wheels. The work rest is shown holding a brass brush-holder casting, the sides of which are ground concentric with a central broached hole, and to uniform thickness within 0.001 inch, in about ten seconds.

Either spindle may be thrown out of gear, locked and the opposite disk wheel moved to the work by hand lever or foot lever, same as with the ordinary double-head grinder. The rocking work rest may be replaced by the ordinary stationary work rest, mounted on the T-slotted pad on the front of the bed casting.

The end thrust of the spindle is taken between pulley and back bearing bushing on a hardened and ground thrust collar of large area. The disk wheels are 18 inches diameter by ⅝ inch thick, but the machine will swing 22-inch disk wheels. The maximum opening between disk wheels is 20 inches.

A feature of this machine, as well as of all other double-head disk grinders built by the Besly Company, is the sliding bearing bushings, which incase the spindle and protect the bearings from grinding dust. Further, the spindle having only about one inch of sliding movement, the disk wheel is always near, and rigidly supported by, the main head casting. This is an important feature in a double-head disk grinder on account of the heavy intermittent load, and consequent strain on disk-wheel end of spindle.

The machine complete with countershaft, press, etc., weighs about 3500 pounds. It is made by Charles H. Besly & Co., 15, 17, 19 and 21 South Clinton street, Chicago, and is designated by them as No. 6.

Lathe Dog

In the lathe dog illustrated the work is protected from being marred by the end of the set-screw, and upsetting or bending of the latter is guarded against by the two removable V-blocks or jaws made of tool steel hardened and tempered. The jaws can be furnished like a pipe vise with teeth for gripping rough stock for high-speed turning, or with brass jaws. The dog is a steel drop forging and is made by the O. K. Tool Holder Company, Shelton, Connecticut.

LATHE DOG

Convention of the National Machine Tool Builders' Association

The National Machine Tool Builders' Association will hold their semi-annual convention at Fortress Monroe, Va., with the Hotel Chamberlain as headquarters, on Tuesday and Wednesday, May 14 and 15, 1907.

A large attendance is assured, and the many interesting subjects that will be brought out, for discussion, will no doubt make it an important gathering.

The membership has been largely increased in the past year, and any manufacturer of machine tools not yet a member is cordially invited to attend this convention, with a view of becoming acquainted with his fellow manufacturers, and thus, perhaps, become an active member.

New Publications

The Cleveland Twist Drill Company has published a very useful set of 6x9½-inch cards, which are hung from a brass ring and intended to be placed in the machine shop for ready reference. Among other things, they contain the dimensions of taper sockets, tapping sizes of drills, the speed of drills, and hints on the use of high-speed steel drills. The cards are heavy and substantial to stand rough usage, and will be found extremely useful. They are published for gratuitous distribution.

THE SCHULZ STEAM TURBINE FOR LAND AND MARINE PURPOSES. By Max Deitrich. 73 6x9-inch pages, with 43 illustrations. E. P. Dutton & Company, New York.

This study of the Schulz turbine is one of a series on modern steam turbines, which, when complete, will comprise descriptions of the leading systems of which encouraging practical trial has been made. The volume is a study of the development and construction of the machine and of the action of steam upon its blades. While devoted primarily to the Schulz machine, various comparisons with others are made from time to time as circumstances demand.

CONTROL OF TRAINS. By E. B. Leigh. 33 pp. 6x9 inches. Reprinted from the *Railway Age*.

This is a plea for the use of brake beams which shall withstand the strains of air-brake service of the present day with less deflection and failure than some which are in use. It contains recommendations in regard to the maximum deflection which should be allowed and quotes from various reports of the Master Car Builders' Association. It also includes the report of the committee of this association on brake beams at the convention of last year, and this report contains many interesting diagrams and figures from tests. It should be appreciated by railroad men who have to do with this part of the road's equipment.

THE THETA-PHI DIAGRAM. By Henry A. Golding. Second revised and enlarged edition; 126 5x7-inch pages, with 48 illustrations. The Technical Publishing Company, Ltd., Manchester and London; the D. Van Nostrand Company, New York. Price, $1.25.

The use of the temperature entropy method of analysis, as applied to steam and gas engines, is much more common in Europe than in this country, and this little book should be of large value to American engine designers, because it presents in condensed form the methods which have been developed in England. These methods were made public through the publication of papers read before the various engineering societies, and the book under notice collects the information thus published, and places it within the reach of all. The book is probably as mildly mathematical as it is possible to make one on this subject, and after explaining entropy and entropy diagrams, it takes up the conversion of indicator diagrams into entropy diagrams, heat losses and the application of the diagram to the steam, gas, oil and air engines. The spirit of the book is entirely graphical, the formidable equations which characterize the standard books on thermo dynamics being conspicuous by their absence.

ARTILLERY AND EXPLOSIVES. By Sir Andrew Noble, Bart. 547 6x9-in. pages, with numerous text cuts, full-page and folded plates. Price, $6.

The author of this volume has been connected with the British naval service for over half a century, during all of which time he has been active as an investigator and student. From time to time he has published papers before various British societies, and these papers are here republished as they were written. The first paper dates from 1858, while the last was read before the Royal Institution in 1890. There is, of course, some repetition, especially as some of the papers are in a measure historical; but the author explains that to have eliminated this feature would have necessitated a re-writing of the entire series of papers, and he has hence published them as they were originally prepared. The student of artillery will be disposed to thank him for his decision, as in no other way could the viewpoint of a student at various periods of time be reproduced as they now are, and the result is a volume which, while perhaps somewhat larger than it might otherwise be, nevertheless possesses an interest which would be impossible in any history of the subject written today. It is not to be understood, however, that the book is primarily a history. On the other hand, the author's researches and analyses are of large scientific and practical importance—the historical features of the book being incidental rather than a matter of original intention.

Personal

Thomas Kirk, formerly with the Bement-Miles Company, of Philadelphia, has accepted a position with the Ridgway (Penn.) Machine Company, succeeding L. H. Morgan as superintendent, ill health compelling Mr. Morgan to resign.

B. F. Murphy has resigned his position with the B. F. Sturtevant Company's New York branch to accept one with the Buffalo Forge Company at its branch office in New York. In accepting the latter position Mr. Murphy returns to a former connection, as he received his initial training in the blower business with the Buffalo Forge Company, at its Buffalo works.

Obituary

William George Gill, consulting engineer, member of the firm of Philip H. Gill & Son, New York City, died at his home in Brooklyn, March 6. Mr. Gill was born in Cornwall, England, 1848.

Gen. Eugene Griffin, first vice-president of the General Electric Company, died at Schenectady, April 11. General Griffin was 52 years of age, and was a member of the American Society of Mechanical Engineers since 1889. He took a prominent part in the affairs of the Engineers' Club, and was actively interested in the Engineering Societies Building, which is to be dedicated on April 16 and 17.

A. J. Cromwell, for many years superintendent of motive power of the Baltimore & Ohio Railroad, and an important factor in locomotive building, died at Baltimore, April 9, at the age of 76 years. Mr. Cromwell entered the company's employ 45 years ago as a machinist and rose in the ranks until he became head of the motive department. He designed many of the improvements to increase the speed of locomotives and planned the engines which established the 45-minute schedule between Baltimore and Washington. He retired several years ago.

Business Items

The C. W. Raymond Company, Dayton, O., manufacturer of clay working machinery, is preparing to build a new factory.

At the recent international exhibition held in Liege, Belgium, the Armstrong Bros. Tool Company, of Chicago, was awarded a medal for its exhibit of lathe and planer tool holders.

The Precision Appliance Company, 832

Austin avenue, Chicago, has purchased all the assets of The Steel Ball Company, from the trustee in bankruptcy and has taken over the business.

The Pittsburgh (Penn.) Automatic Vise and Tool Company contemplates starting a plant in Europe. Its vises are said to be thoroughly covered by patents in almost every country.

The Wilmarth & Morman Company, of Grand Rapids, reports that its shipments of drill grinders and loose pulleys the past three months were 50 per cent. more than for the similar period a year ago.

The Diehl Manufacturing Company, Elizabeth, N. J., manufacturer of electric motors, dynamos, electric fans, etc., has opened a Baltimore office at 217 N. Calvert street, with H. A. Thomas as manager.

J. H. Dohner, for a number of years with the National Cash Register Company, has accepted a position as assistant general superintendent with the National-Acme Manufacturing Company, Cleveland, Ohio.

The Crocker-Wheeler Company, manufacturer and electrical engineer, of Ampere, N. J., has established a branch in Birmingham, Ala., with B. A. Schroeder as manager. The new office is in the Woodward building.

The Goldschmidt Thermit Company's offices are now located on the 14th floor of the West Street Building, 90 West Street, New York City. The company has also opened an office at 432-436 Folsom street, San Francisco, under the management of L. Heynemann.

The Cincinnati (Ohio) Planer Company has broken ground for a new plant at Oakley, Ohio, a suburb of Cincinnati, where eight acres have been secured. A brick and steel structure of 140 by 200 feet will be erected, equipped with new machinery throughout and operated in addition to its present plant. When completed a second building of the same dimensions will be built and the entire plant moved to the new location. Other manufacturers locating in the same vicinity are the Cincinnati Milling Machine Company, The Bickford Drill and Tool Company, and the Triumph Electric Company. A central power company owned by the four concerns will furnish heat, light and power to the plants.

On May 1, the Chicago branch of Niles-Bement-Pond Company will occupy its new offices on the sixth floor of the new Commercial National Bank Building, Clark and Adams streets, Chicago. Pratt & Whitney Company will abandon its show room and offices at No. 46-48 South Canal Street, and will combine its machinery sales department with that of Niles-Bement-Pond Company. The show room and stock of Pratt & Whitney small tool and the small tools sales department will be located on the ground floor of the new Plamondon building, Clinton and Monroe streets, where a complete line of Pratt & Whitney small tools and gages will be carried in stock. Geo. F. Mills, who has for several years looked after the interests of these companies in the Chicago territory, will continue as manager of the Chicago offices.

Trade Catalogs

P. Dupressoir, Constructeur, Maubeuge (Nord) France. Catalogs of "Rolling' automobiles. Illustrated.

Rochester Gas Engine Company, Rochester, N. Y. Catalog of marine engines. Illustrated, 48 pages, 6x9 inches, paper.

The Veeder Manufacturing Company, Hartford, Conn. Booklet No. 103 describing counters. Illustrated, 12 pages, 3x6 inches, paper.

Goldschmidt Thermit Company, 90 West street, New York. Catalog describing the Thermit welding process. Illustrated, 16 pages, 9x12 inches, paper.

Standard Safety Air-Cushion Company, 31-33 Broadway, New York. Catalog of safety-air cushions for elevators. Illustrated, 7½x10 inches, paper.

R. D. Wood & Company, Philadelphia, Penn. Catalog of centrifugal pumps for water works and high pressure fire service. Illustrated, 35 pages, 6x9 inches, paper.

Jeffrey Manufacturing Company, Columbus, Ohio. Illustrated. Supplement of conveying machinery for saw mills, lumber mills and wood working industries. 72 pages, 6x9 inches, paper.

Manhattan Electrical Supply Company, 17 Park Place, New York. Catalog No. 22 entitled "Something Electrical for Everybody," which includes electricians' supplies, telegraph instruments and supplies, automobile sundries, etc. Illustrated, 144 pages, 4x8½ inches, paper.

Manufacturers

The Pacific Metal Works, Portland, Ore., will erect a new plant.

The Rochester (N. Y.) Non-Rust Tinware Company will erect a large new plant.

The H. J. Hartman Foundry Company, Grand Rapids, Mich, will build an addition.

Confer, Smith & Co., iron founders, Hamburg, Pa., will erect an addition to their plant.

The Aluminum Manufacturing Company, Two Rivers, Wis., will erect a $22,000 addition.

The Genesee Tack Company, Rochester, N. Y., will erect a new plant at a cost of over $13,000.

The Union Screw Company, Cleveland, O., will erect a new plant at a cost of about $50,000.

The Manufacturers' Foundry Company, Waterbury, Conn., will erect two new foundry buildings.

The Trahern Pump Company, Rockford, Ill., will enlarge its plant, doubling its present output.

The Stearns Gas Engine Company, Los Angeles, Cal., is constructing a new $10,000 factory building.

The Republic Stamping and Enameling Company, Canton, O., is erecting a new plant, to cost $400,000.

The Standard Textile Company, Fort Edward, N. Y., whose plant was recently burned, will rebuild at once.

The Royal Crown Lead Company, of Detroit, Mich., will erect a factory in Minneapolis, to cost $50,000.

The Vanderman Plumbing and Heating Company, Willimantic, Conn., will build an addition to the foundry.

The Connecticut Telephone and Electric Company, Meriden, Conn., will erect a four-story addition to its plant.

Work has been started on the new machine shop for the American Steam Pump Company, Battle Creek, Mich.

The Sterling Engine Company, Buffalo, N. Y., has increased its capital stock and will erect a new $20,000 building.

D. & H. Scovil, Higganum, Conn., manufacturers of farming implements, are erecting two additional factory buildings.

Plans have been drawn for an enlargement to the foundry and backsmithing department of Girard College, Philadelphia, Pa.

The Theodore C. Fedders Manufacturing Company, Rochester, N. Y., making automobile supplies, will erect a new factory.

Plans are being prepared by the Boston & Albany Railroad for the enlargement of the motive power shops in Merrick, Mass.

Plans have been completed for the new factory and boiler house to be erected for the Geometric Tool Company, Westville, Conn.

The American Brake Shoe and Foundry Company will erect another plant at Chattanooga, Tenn., at a cost of over $50,000.

The Emerson Manufacturing Company, Rockford, Ill., makers of agricultural implements, will build four additions to its plant.

Carl Spoerer's Sons, Baltimore, Md., have awarded contracts for the erection of a carriage and automobile factory to cost about $20,000.

The National Manufacturing Company, Sterling, Ill., making hardware specialties, will erect a three-story factory to cost $15,000.

Plans and specifications have been received at Washington for a new wire-rope mill at the Charlestown navy yard. This will cost about $75,000.

The Frisco Railway has appropriated $1,000,000 for the purchase of grounds and erection of machine and repair shops in Evansville, Ind.

The United States Steel Lock Company, Lyons, Iowa, will erect an addition to its foundry and another for its polishing and plating department.

Rackliffe Bros., Inc., Hartford, Conn., manufacturers of sashes, doors and blinds, will erect a new four-story factory building. Electric power will be used.

The Southern Pacific Railroad has planned new buildings for its yards at Los Angeles, Cal., including a two-room oil car repair shop, blacksmith shop, etc.

The Joliet (Ill.) Iron Products Company, a new concern capitalized at $200,000, has purchased a site for its plant. J. J. Gaskill, D. H. Lentz and others, incorporators.

The Mayo Iron Works, Richmond, Va., a newly chartered concern, and which absorbed the Cameron-Tennant Machine Works, will make extensive alterations and additions to the present plant.

The Kansas City (Mo.) Railway Foundry Company is erecting a plant at Sixth street and Walker avenue, West Side, for the manufacture of lubricating cups and journal boxes. A. F. Reitz is president.

C H. Chandler, of the Chandler Pump Company, Cedar Rapids, Iowa, is interested in a new radiator manufacturing plant now being put up, which will conssist of a foundry, machine shop and power house.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 75 Broad St., New York.

Caliper catalog free. E. G. Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery to order, carbon and other molds specialty. O. Anderson, 30 Lawrence St., Newark, N. J.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery, toolmakers, screw machine products and manufacturers. Gierth & Richards, 251-255 Elm St., Newark, N. J.

Wanted—Manufacturer to build in quantities, a new type of standard machine (compressor) in steady demand. Address R. C. Co., Box 821, Pittsburg, Pa.

Wanted—Machine work for lathes, planers and boring mill in a shop well equipped to handle medium and heavy work. Manufacturer, P. O. Box 217, Dayton, Ohio.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Small automatic machinery for special work, models, jigs, etc., built to order. Satisfaction guaranteed. Novelty Engineering Association, Box 264, Fitchburg, Mass.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Experimental engineer, now in charge with large corporation, desires to undertake in spare time development of ideas on automatic or other machinery; communication solicited. Box 859, AMERICAN MACHINIST.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHNIST.

Wanted—To buy patent, or manufacture under royalty, any specialty where high-grade grey iron castings constitute 60 per cent. or more of total cost; would also consider New England or Eastern rights to established article. "Founder," Care AMER. MACHINIST.

Draftsman, engineers, learn automobile drafting and designing including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th Street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

The shops of the Motor Car Specialty Company, at Trenton, N. J., in addition to building speed meters and other high-class speed recording instruments, are open for the manufacture of light high-grade machinery, on contract or royalty basis, either in large or small quantities.

To builders of machinery: wanted; a company with thoroughly equipped shop and plenty of cash to build an automatic screw machine which is fully up to date; beyond the experimental stage, having been building for 10 years and will execute twice the work of any single spindle. Box 872, AMER. MACH.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

A prosperous manufacturer in the States desires to establish a factory in Canada and would deal with a capable young man who can invest $25,000 to $30,000 and take charge of the business, a man familiarwithsteam engines or steam engine specialties preferred. This is an exceptional opportunity for a young man to establish himself in business, for the proposition is open to full investigation. Address "Opportunity," AMER. MACH.

We build machines or parts on rush orders. A modern shop equipped with milling machines, drill presses, universal grinders, stamping press, automatic screw cutting machine and lathes, will take contracts for the quick delivery of articles that can be built in such a shop. Send drawings and specifications or samples and estimates will be returned with guarantee of quick delivery. We also build models and do experimental work. Address Box 830, AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNNECTICUT

Superintendent wishes to make a change, accustomed to fine and medium heavy interchangeable work; a designer of modern tools, jigs, and special machinery for rapid production. Box 784, AMERICAN MACHINIST.

As superintendent or machine shop foreman; thorough mechanic, up to date; tactful with help, large experience in building machinery; also tools and repairs; best of references. Box 871, AMER. MACHINIST.

ILLINOIS

Draftsman—Engineer in charge of large drafting room in the West wants work in the East Box 776, AMERICAN MACHINIST.

Situation wanted as superintendent of foundry and pattern shop; by one that has and can produce results. Address Box 864, AMERICAN MACHINIST.

Wanted—Situation as foreman pattern maker; 10 years' experience with a record second to none. Address Wm. Smith, 427 West Allen St., Springfield, Ill.

MASSACHUSETTS

Blacksmith foreman desires change. Box 809, AMERICAN MACHINIST.

Draftsman; mechanical; 3 years', 10 months' machinist apprentice; experienced in boiler and general machine work; desires position as draftsman or erector. "W. W.," Box 845, AMERICAN MACHINIST.

MICHIGAN

Wanted—Position as superintendent or general foreman; experienced; light or medium work; large volume, first-class references. Box 862, AMERICAN MACHINIST.

NEW JERSEY

Practical man; 29; drop forge and engine experience; five years' estimating and general engineering work, outside preferred; will go on road. Address Box 874, AMER. MACH.

Graduate of German university wants position; practice in steam turbine work; familiar with all kinds of figuring; any location. Box 870, AMERICAN MACHINIST.

A-1 mechanic with exceptional inventive and organizing ability; experienced on small and medium interchangeable work and who can handle help to advantage, desires position of some responsibility. Box 878, AM. M.

Superintendent; thorough mechanic; age, 42; good executive; can install complete cost system; up to date on interchangeable; jig and tool work; good designer; best of reference. Box 866, AMERICAN MACHINIST.

NEW YORK

Experienced mechanical draftsman desires position. Box 869, AMERICAN MACHINIST.

Master mechanic; 25 years experience on machinery, tools and instrument work; desires position in New York or New Jersey. Address Box 840, AMERICAN MACHINIST.

Mechanical man; experience drafting, designing automatic machines; transmission, and in charge in general is open for engagement. Box 858, AMERICAN MACHINIST.

Mechanical engineer and draftsman; graduate German; age 25; 4 years' experience; desires change; New York or New Jersey preferred. Box 822, AMERICAN MACHINIST.

Superintendent; age 37; wide experience on interchangeable work, special machinery and metal specialties; executive ability and excellent manager of men. Address Box 802, AMERICAN MACHINIST.

Mechanical superintendent, employed, desires to make a change; expert toolmaker, machinist, designer and manufacturing economist; strong executive; salary secondary consideration. Box 795, AMERICAN MACHINIST.

OHIO

Draftsman (detailer and tracer) age 19; at present employed; wishes to change position; two years experience in Corliss engine, mining machinery and structural iron works. Box 868, AMERICAN MACHINIST.

PENNSYLVANIA

Machine shop foreman desires position; experienced toolmaker; good executive. Box 876, AMERICAN MACHINIST.

Superintendent, shop manager; high-grade factory executive, wants to change; west or south preferred. Box 834, AMER. MACH.

Superintendent or foreman; expert in manufacturing methods, several years' experience as executive, hustler and cost reducer; furnish best references from present employer. Box 875, AMERICAN MACHINIST.

Wanted—Position as superintendent or shop manager; technical and practical training of 22 years; designed, built and equipped three modern plants; good organizer, systematizer and up to date on modern methods of production. Box 828, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent to take charge of small hardware manufacturing plant, capable of developing into a very large industry, must be a worker, good handler of men and capable of designing tools to produce goods at lowest possible cost; opportunity for ambitious worker. Address, stating salary wanted to "Canada," AMERICAN MACHINIST.

CONNECTICUT

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Competent machinist and toolmaker to take general charge of tool room in a Connecticut manufacturing concern; must be up-to-date. Apply giving age, experience and reference to Box 863, AMERICAN MACHINIST.

FLORIDA

Wanted—Boilermakers and machinists experienced on marine work; pay from $3.68 to $2.32 per diem. Apply to Board of Labor Employment, Navy Yard, Pensacola, Fla.

GEORGIA

Wanted—Machinists to work in one of the best shops in Atlanta; good places for good men; open shop. E. Van Winkle Gin & Machine Works, Atlanta, Ga.

ILLINOIS

Wanted—Foreman in the jobbing and special order department of large sheet metal works; department embraces light and heavy sheet metal of all description; applicant must have large experience and executive ability; German preferred; salary $1500. Address Box 803, AMERICAN MACHINIST.

INDIANA

Wanted—Toolmakers; lathe hands, and assemblers; good wages; steady employment; Western Motor Co., Logansport, Ind.

MASSACHUSETTS

Wanted—An experienced sewing machine adjuster and mechanic familiar with overstitch machines. "United," AMER. MACH.

Wanted—A foreman for machine department for a progressing manufacturing concern; good position for right man. Address Box 857, AMERICAN MACHINIST.

Good mechanical draftsman for design of measuring instruments wanted by manufacturing concern near Boston; address with full information regarding age, education, experience and salary expected to Box 838, AMERICAN MACHINIST.

Wanted—Tool and die makers accustomed to accurate, complicated work; steady work to thoroughly competent men; wages 40c. per hour subject to a liberal increase after showing the necessary ability; give references. Address The D. F. Briggs Co., Manufacturing Jewelers, Attleboro, Mass.

Wanted—Young machinist who has had drafting room experience to be assistant manager of a plant building fine machinery; must be sober, honest, willing to work hard; exceptional chance and interest in business to any one who can prove his ability; give age, experience and references. Box 832, AMERICAN MACHINIST.

MICHIGAN

Machinists Wanted—First-class machine hands and floor hands on heavy work; steady employment assured. Northern Engineering Works, Detroit, Mich.

MISSOURI

Wanted—First-class adjusters accustomed to adding machine and typewriter work. Universal Adding Machine Co., St. Louis.

Draftsman Wanted—Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Mechanical draftsman; must have had some experience in tools, jigs; state experience and salary expected. Box 873, AM. M.

Wanted—Tool, die and instrument makers accustomed to accurate, complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Several competent mechanical draftsman wanted with experience on general engineering and construction work; good positions for the right parties assured; none but Amer-

icans need apply; state age, salary expected and give references. Box 861, AMER. MACH.

NEW YORK

Wanted—Patternmaker at McEwen Bros., Wellsville, N. Y.

Wanted—Experienced diemaker on drop-forging dies. Box 842, AMER. MACHINIST.

Wanted—Two draftsmen and three tracers on drawings for construction work; state age and salary. Box 877, AMERICAN MACHINIST.

Wanted—Experienced draftsman, toolmakers and machinists; give age, references and wages expected. Remington Arms Co., Illion, N. Y.

Wanted—Several first-class mechanical and electrical draftsmen. Apply, giving age, experience and salary expected to Engineer in Charge, Drafting Department, General Electric Company, Schenectady, N. Y.

Toolmaker to devise methods, tools and fixtures for rapid production, to take charge of a small tool room as working foreman, and to repair machine tools; a permanent position; state experience, references, age and pay expected. Address Green Fuel Economizer Co., Matteawan, N. Y.

OHIO

Wanted—One machinist experienced on a 3-A heavy Brown & Sharpe Universal Milling machine. State wages expected and experience. Leidecker Tool Co., Marietta, O.

Wanted—Superintendent for machine shop on small tools, must be a toolmaker, machinist and know how to get work out quickly, and manage the shop. State what kind of business you have had experience in, also salary expected, etc, Box 865, AM. MACH.

Wanted—Mechanical drawing checker; an experienced, practical and reliable man, age 30 or more, wanted by a large automobile manufacturer; must be experienced and have good mechanical ability to check drawings, see that parts will assemble without interference, and make estimates of material required in construction; permanent position and good salary for right man; references. Address Box 801, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Capable diemakers to work on heavy drop-forge dies; steady work for the proper applicants. Apply, giving references, as well as wages expected. Box 705, AMERICAN MACHINIST.

Foreman; ambitious, capable machinist, accustomed to die work, and economical manufacture of sheet metal goods and stampings; also experimental work; must handle men well; would arrange working interest for good man; business in growing prosperous condition; splendid business future awaits such a man; give experience, age, references, etc. Wolverine Mfg. Co., Pittsburg, Pa.

Wanted—First-class automatic screw machine operator who is capable to cam up new jobs on Cleveland automatic screw machines, design tools for the operation, and who can keep machines in repair. Must be first-class toolmaker and capable of handling men; will have charge of twenty-four 2" and 2¼" machines and also of toolroom; only first-class man should apply. Address, giving age, experience and references, F. K. Landgraf, Bridgeville, Pa.

RHODE ISLAND

We are continually adding to our force, experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery. Good wages and steady employment. Apply to Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

Wanted—A good superintendent capable of handling pattern shop, foundry and machine shop departments in a general jobbing, repairing and manufacturing shop located in a rapidly growing city of two hundred thousand inhabitants, center of a big lumbering country in the West; one who could invest about $10,000 preferred. An excellent opening for the right man. Full investigation demanded and given. Address Box 692, AMERICAN MACHINIST.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

Wood pattern business for sale; centrally located in New York City; excellent opportunity. Box 860, AMER. MACHINIST.

For Sale—Jobbing iron and brass foundry, located in western Pennsylvania; price $6000. Address Box 813, AMERICAN MACHINIST.

For Sale—Locksmith and light repair shop; lathe and milling machine; good for one or two men. Box 531, Bellows Falls, Vt.

An established engine lathe business in city of 50,000; reasons to enlarge foundry and limit business to that branch. Address Box 645, Springfield, Ohio.

For Sale—Cyclopedia of modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

For Sale—Practically new Pratt & Whitney 9" Pillar shaper, cutter head having stroke of 10"; in excellent condition; reason for selling too small range for our work. Address Box 855, AMERICAN MACHINIST.

For Sale—Large power punch press; Bliss, Stiles, No. 4 geared; weight, 6600 lbs.; opening, 9"x12"; stroke 1½"; perfect order; used six months; reason for selling, changing character of work. Knapp Electric & Novelty Co., 513, W. 51st St., New York.

We offer for sale at a sacrifice a standard patented tool which has been on the market for four years, and extensively advertised, together with jigs, tools, dies, crude and finished product; orders turned over to the purchaser; best reason for selling. Address P. O. Box 635, Warren, Pa.

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Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.

Aftercoolers, Air

Ingersoll-Rand Co., New York.

Air Lifts

Ingersoll-Rand Co., New York.

Alundum

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Arbor Presses

Barnes Co., W. F. & John, Rockford, Ill.
Bartlett, E. E., Boston, Mass.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors

Butterfield & Co., Derby Line, Vt.
Cochrane-Bly Co., Rochester, N.Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Union Twist Drill Co., Athol, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Architects

Ballinger & Perrot, Phila., Pa.
Dodge & Day, Philadelphia, Pa.

Barrels Steel

Lyon Metallic Mfg. Co., Aurora, Ill.

Barrels, Tumbling

Baird Machine Co., Oakville, Ct.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Bearings, Ball and Roller

Boston Gear Works, Norfolk Downs, Mass.
Hyatt Roller Bearing Co., Harrison, N. J.
Standard Roller Bearing Co., Philadelphia, Pa.

Belt Dressing

Cling-Surface Mfg. Co., Buffalo, N. Y.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Schieren & Co., Chas. A., New York.
Rhoads & Sons, J. E., Phila., Pa.
Shultz Belting Co., St. Louis, Mo.

Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

Belting, Leather

Main Belting Co., Phila., Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Bending Machinery, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machinery, Plate

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

Bending Machinery, Power

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Foundry & Mach. Co., South Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Bending Tools, Hand

Wallace Supply Co., Chicago, Ill.

Blanks, Nut and Screw

Dyson & Sons, Jos., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chain

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Blowers

American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.
Keuffel & Esser Co., New York.
Soltmann, E. G., New York.

Blue Print Paper

Keuffel & Esser Co., New York.

Boilers

Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
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Detrick & Harvey Mach. Co., Baltimore, Md.
Foote-Burt Co., Cleveland, O.
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Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Mfg. Co., G. M., Mechanicsburg, Pa.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Sames, C. M., Jersey City, N. J.

Boosters
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertam & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Inc., Boston, Mass.
Kern Machine Tool Co., Cincinnati, Ohio.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills, Vertical
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, Ohio.

Boxes, Tote
Lyon Metallic Mfg. Co., Aurora, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Brakes, Magnetic Friction
Electric Controller & Supply Co., Cleveland, O.

Brazing
Reinforced Brazing & Machine Co., Pittsburg, Pa.

Broaching Machines
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Lapointe Mach. Tool Co., Hudson, Mass.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Hammacher, Schlemmer & Co., New York.
Lyon Metallic Mfg. Co., Aurora, Ill.

Calipers
Athol Mach. Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Bilgram, Hugo, Phila., Pa.
Boston Gear Works, Norfolk Downs, Mass.

Carborundum
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Cast Iron Brazing
Reinforced Brazing & Mach. Co., Pittsburgh, Pa.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.
Nolte Brass Co., Springfield, O.
Phosphor Bronze Smelting Co., Philadelphia, Pa.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Fairbanks Co., Springfield, O.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.

Castings Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co. Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Phœnix Mfg. Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Mach. Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Wks. Co., Cin., O.
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.

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Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown Co., R H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
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Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Mfg. Co., G. M., Mechanicsburg, Pa.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.

Clutches, Friction
American Tool & Machine Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.
Jacobson Mach. Mfg. Co., Warren, Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, Ohio.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collectors, Pneumatic
Sturtevant Co., B. F., Boston, Mass.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compound, Cutting
New York Lubricating Oil Co., New York.

Compound, Slushing
Warren Bros. Co., Boston, Mass.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Sampson & Co., Geo. H., New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Leard, Wm. E, New Brighton, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Machine Co., Boston, Mass.
Skinner Ship Bldg. & Dry Dock Co., Baltimore, Md.
Turner Mach. Co., Danbury, Conn.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker-Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Corundum
See Grinding Wheels

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters Machinery
Veeder Mfg. Co., Hartford, Ct.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Cresson Co., Geo. V., Phila., Pa.
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Electric Controller & Supply Co., Cleveland, Ohio.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes

Brown Hoisting Mach. Co., Cleveland, Ohio.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.

Crank Shafts

Bethlehem Steel Co., So. Bethlehem, Pa.
Leard, Wm. E., New Brighton, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.
Winkley Co., Detroit, Mich.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hill, Clarke & Co., Inc., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Mach. Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fairbanks Co., Springfield, Ohio.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Cyclometers

Veeder Mfg. Co., Hartford, Ct.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York City.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edw. R., Chicago, Ill.
Mossberg Wrench Co., Central Falls, R. I.

Dies, Sub-Press

Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Boker & Co., Hermann, New York.
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins

Winkley Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.
Economy Drawing Table Co., Toledo, Ohio.
Keuffel & Esser Co., New York.
Mittineague Paper Co., Mittineague, Mass.
Rich, J. & G., Phila., Pa.
Soltmann, E. G., New York.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.

Drawing Materials—*Cont.*

Mittineague Paper Co., Mittineague, Mass.
Rich, J. & G., Phila., Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Slate Mach. Co., Dwight, Hartford, Conn.

Drilling Machines, Boiler

American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric

Chicago Pneumatic Tool Co., Chicago, Ill.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.

Drilling Machines, Radial—*Continued.*

Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co, New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret

National Separator & Mach. Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Burke Mchry. Co., Cleveland, O.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, Ohio.
Knight Machry. Co., W. B., St. Louis, Mo.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc, Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center

Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand

Coates Clipper Mfg. Co., Worcester, Mass.
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

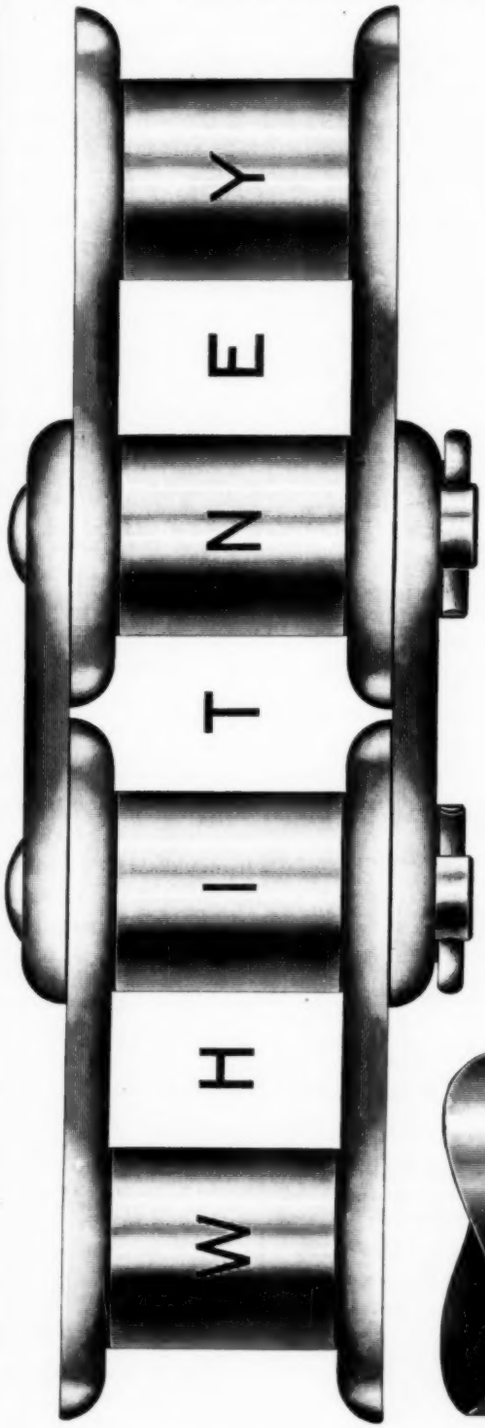
Drills, Rail

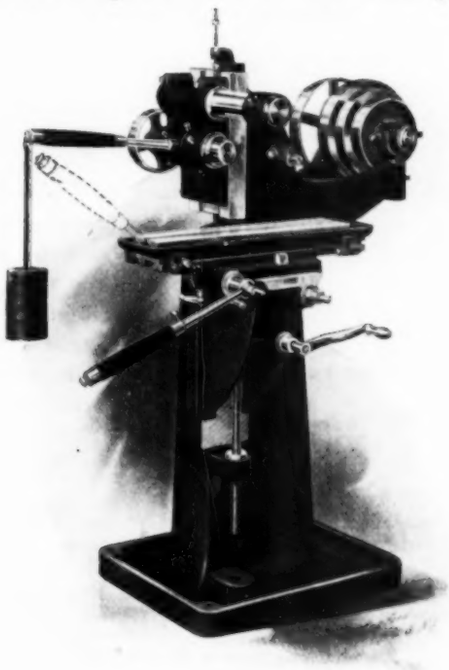
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Foote-Burt Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

"WHITNEY" CHAINS

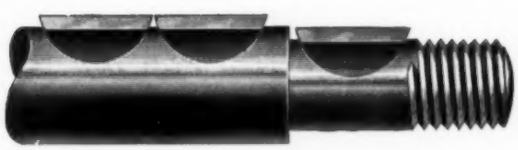
Hand (feed) Milling Machines

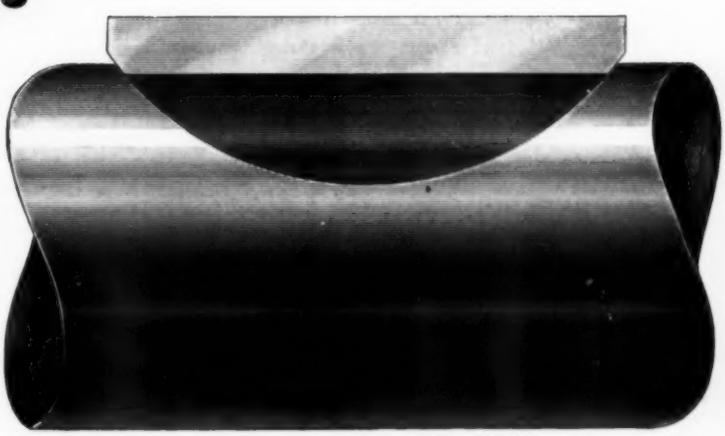
The Woodruff Patent System of Keying





The New Model.





The Whitney Mfg. Co., Hartford, Conn., U.S.A.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Keystone Mfg. Co., Buffalo, N. Y.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison Wis.

Drill Speeder

Graham Mfg. Co., Providence, R. I.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies

Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Triumph Elec. Co., Cincinnati, O.
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Lincoln Motor Wks. Co., Cleveland, O.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

Amedican Emery Wheel Co., Providence, R. I.
Desmond-Stephan Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York City.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room

Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances

Lunkenheimer Co., Cincinnati, O.
Williams Valve Co., D. T., Cincinnati, O.

Engineers, Consulting, and Mechanical

Ballinger & Perrot, Philadelphia, Pa.
Dodge & Day, Philadelphia, Pa.
Thompson, Hugh L., Waterbury, Conn.

Engineers, Electrical

Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile

Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.

Engines, Gas and Gasolene

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Foos Gas Engine Co., Springfield, Ohio.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Jacobson Mach. Mfg. Co., Warren, Pa.
New Era Gas Engine Co., Dayton, O.
Olds Gas Power Co., Lansing, Mich.
St. Marys Mach. Co., St. Marys, Ohio.
Struthers-Wells Co., Warren, Pa.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engravers

Bormay Engraving Co., New York.
Standard Engraving Co., New York.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Machinery Exchange, Boston, Mass.
Philadelphia Bourse, Phila., Pa.

Expanders, Tube

Nicholson & Co., W. H., Wilkes-Barre, Pa.

Factory Equipment

Lyon Metallic Mfg. Co., Aurora, Ill.

Fans, Electric

Backus Water Motor Co., Newark, N. J.
Crocker-Wheeer Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Backus Water Motor Co., Newark, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps

American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co, New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filler, Iron

Felton, Sibley & Co., Phila., Pa.

Filing Machines

Cochrane-Bly Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.
Simplex Mfg. Co., New York.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Mchy. Co., Cleveland, O.
Gem Mfg. Co., Pittsburg, Pa.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Page-Storms Drop Forge Co., Springfield, Mass.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Hydraulic

Bethlehem Steel Co., So. Bethlehem, Pa.
Wyman & Gordon Co., Worcester, Mass.

Forgings, Machine

Dyson & Sons, Jos., Cleveland, O.

Forgings, Steel

Baldwin Steel Co., New York.
Bethlehem Steel Co., So. Bethlehem, Pa.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon Co., Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers

Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Fexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Turner Brass Works, Chicago, Ill.

Furnaces, Oil

Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop

Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters

Sturtevant Co., B. F., Hyde Park, Mass.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester, City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co, L. S., Athol, Mass.

Gages, Steam

Crosby Steam Gage & Valve Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

Gear Cutting Machinery

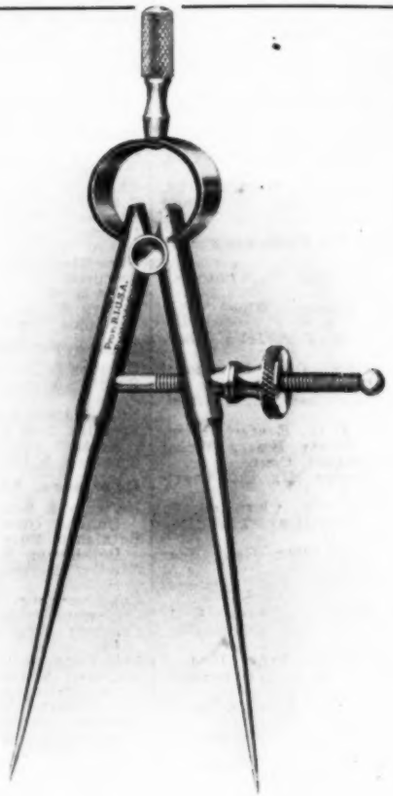
Adams Co., Dubuque, Iowa.
Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros., Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Machine Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bair & Gazzam Mfg. Co., Pittsburg, Pa.
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
delphia, Pa.
Earle Gear & Machine Co., Phila-
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.



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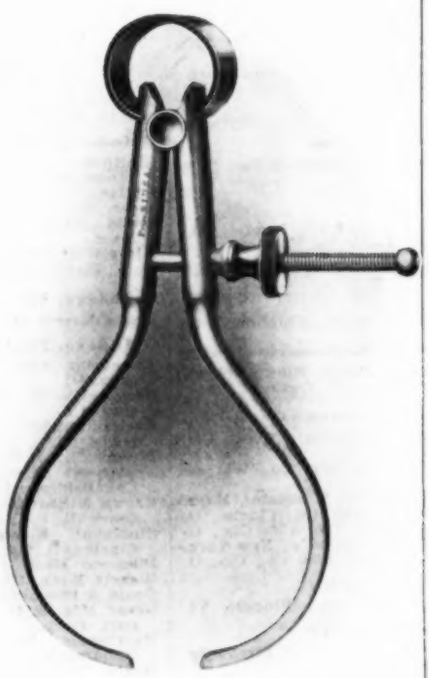

Gears, Cut—*Continued.*

Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees-Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

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Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center

Cincinati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cock

Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.

Grinders, Cutter—*Continued.*

Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Machine Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk

Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Iroquois Mach. Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill

Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Machine Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Machine Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw

Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Grinders, Tool

Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding and Polishing Machinery

Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Burke Mchry. Co., Cleveland, O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Goodell-Pratt Co., Greenfield, Mass.
Graham Mfg. Co., Prov., R. I.
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Iroquois Mach. Co., New York.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Royersford Fdry. & Machine Co., Royersford, Pa.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Wells Sons Co., F. E., Greenfield, Mass.

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Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Cortland Cor. Wheel Co., Cortland, N. Y.
Diamond Mach. Co., Prov., R. I.
Hampden Corundum Wheel Co., Brightwood, Mass.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Pike Mfg. Co., Pike, N. H.
Safety Emery Wheel Co., Springfield, O.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

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Niles-Bement-Pond Co., New York.
Pike Mfg. Co., Pike, N. H.

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Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.

Hammers, Drop—*Continued.*

Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Chicago Pneumatic Tool Co., Chicago, Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power

Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., New Haven, Ct.

Hammers, Steam

Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Erie Foundry Co., Erie, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool

Cincinnati Ball Crank Co., Cincinnati, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting

Link-Belt Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water

Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus

Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm

Gould & Eberhardt, Newark, N. J.
Grant-Lees Mach. Co., Cleveland, Ohio.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery

Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Boston, Mass.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric

C & C Electric Co., New York.
Case Mfg. Co., Columbus, Ohio.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.

Construction of Conical Roller Bearings

As Illustrated from the Practice in the Various Departments of the Timken Roller Bearing Company's Shop at Canton, O.

BY HUGH DOLNAR

Engineers and machine constructors have long been aware of the difficulties of making and using plain bearings for the running parts of machines. A bearing, or journal and box, may be anything from a bullock-cart wheel and axle, both of wood and never oiled, and making no pretense to a fit, to the hardened-steel pivots of watch parts, running in cups formed in rubies or sapphires. A bearing may be a soft-steel shaft running in some alloy, of copper and tin usually, from the 95 tin and 5 copper of the "genuine" babbitt down through the whole list of bronzes; or it may be a hardened and ground steel cylinder running in a hardened and ground steel box, or a coned journal, or a coned step; but if the bearing is two plain pieces of metal, one running and fitting the other, then it is imperative that the sliding friction thus established should be lessened by a film of oil or other efficient lubricant, introduced between the journal of the revolving shaft and the surface of the box in which it is supported as it revolves.

Endless varieties of means and methods relating to the lubrication of bearings have been produced, and bearings carrying heavy loads have had the lubricating oil so well placed in cavities in the box and so equitably applied by wicks that the assembly ran well when only attended by hand once in a year. But the oiled bearing is always uncertain in action, and a great many attempts have been made to substitute round pieces of metal, rollers, balls or cones in forms, for the globular atoms which are supposed to give bearing lubrication its friction-reducing value, and it has been found that many of the journal-box additions which substitute rolling support for sliding support in journal boxes effect great savings in highly important directions.

Comparative Friction

The best plain bearing that can be made, when flooded with the best lubricant, has more friction when carrying a given load than the best of ball or roller bearings; and an ordinary journal bearing, oiled in the ordinary manner, may have five times as great friction losses as the same work done on rolling support. The sliding support also requires the greater length of bearing, so that the use of rolling support effects material savings in the over-all dimensions of a given machine, while the "Friction of Rest," which makes machines with plain bearings hard to start and slow to reach normal speed, almost disappears when the wearing surfaces are carried on rolling support.

History repeats itself. In precisely the same way that the friction-reducing values of the ball bearing first came into full general and popular recognition through the bicycle, where the rider's own muscles told him with the most convincing certainty what bearings ran easiest, so now the motor car is showing what bearings can give the most speed with a motor of relatively small power, or enable a gallon of gasolene to drive a given weight the most miles on the road; and the popular decision is now altogether in favor of rolling support for moving surfaces, as opposed to sliding support with lubrication.

The Demand of the Buyer

At first, ball-bearing balls below proper size for load carried and ball-bearing adjustability gave plenty of trouble in motor cars, and roller bearings gave trouble, too, and ran hard besides, so that for some years the hardened and ground plain journal in a bronze, babbitt or hardened and ground steel box had ardent supporters, who claimed simplicity and durability as a sufficient offset to the somewhat less friction losses of the rolling-support bearings. But now the voice of the purchaser, which must dictate practice, no matter what the traditions of the elders or the dictum of the laboratory may be, declares emphatically in favor of rolling support, and it is not too much to say that at this moment the problem of the best rolling-support machine bearing is one of the very first-class riddles of machine construction at large.

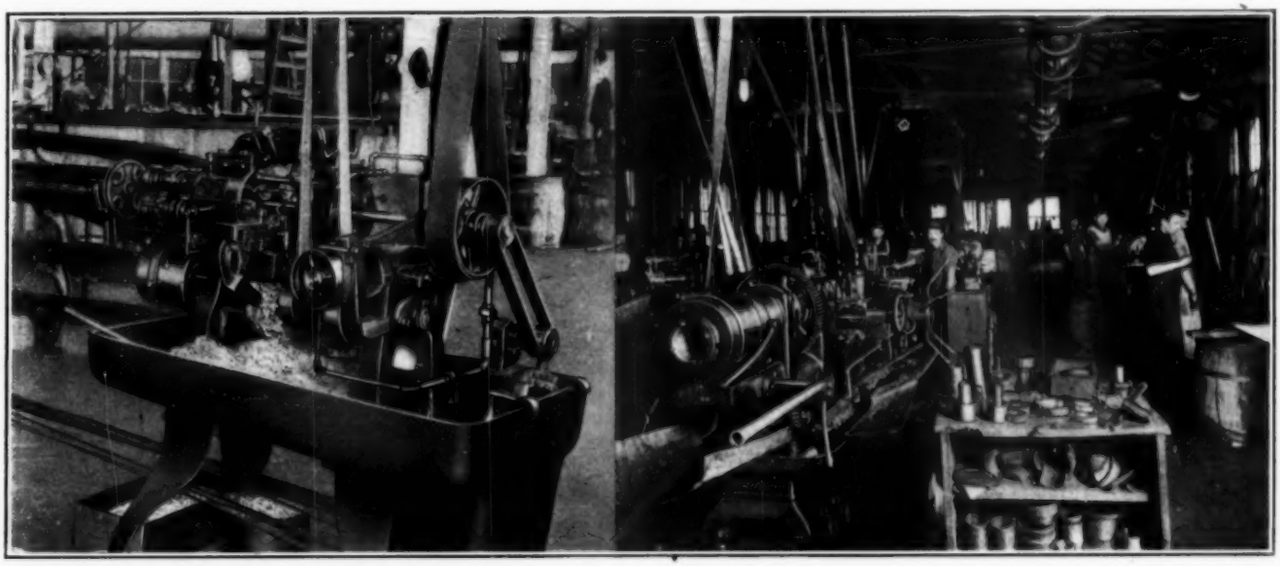


FIG. 1. FOUR-SPINDLE SCREW MACHINE FOR MAKING ROLLERS

FIG. 2. HEAVY SCREW MACHINES TAKING BARS UP TO SIX INCHES

Area of Support

Coned rollers have, theoretically, lines of support, as contrasted with the points

FIG. 3. WHERE WORK IS PACKED FOR CASE-HARDENING

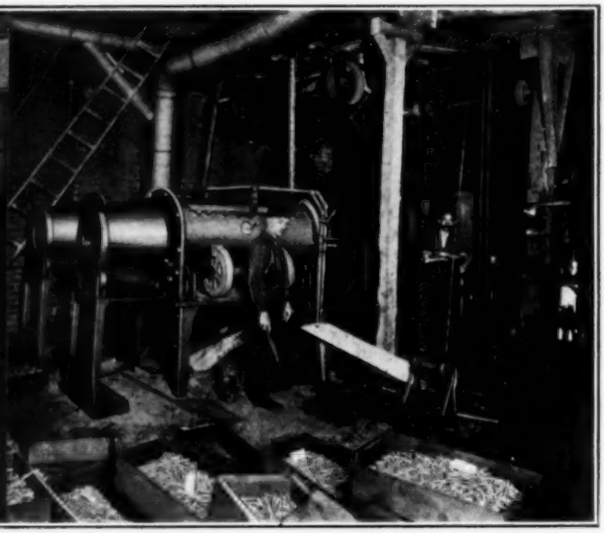
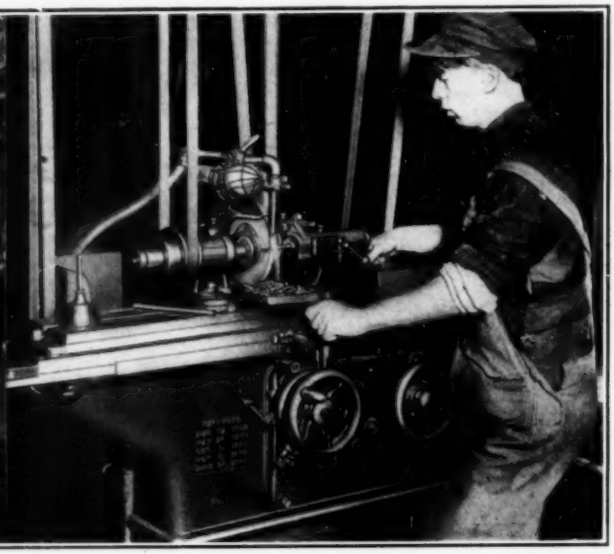


FIG. 4. REVOLVING AMERICAN GAS FURNACE FOR HARDENING



FIGS. 5 AND 6. GENERAL GRINDING ROOM. GRINDING 8 TO 10 CONE ROLLERS A MINUTE

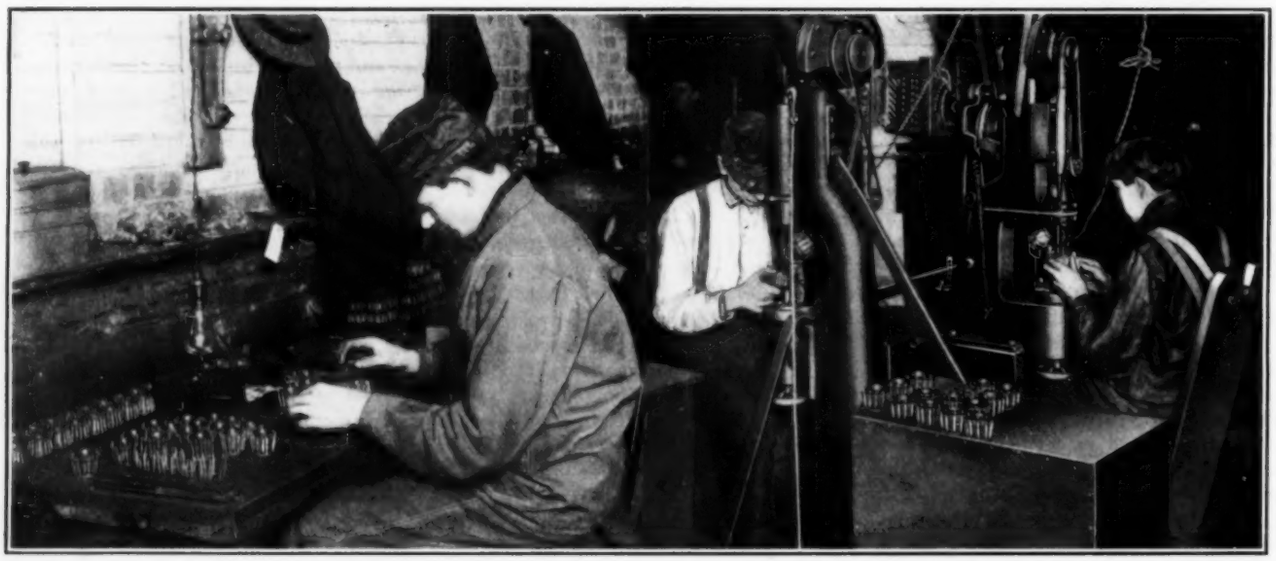
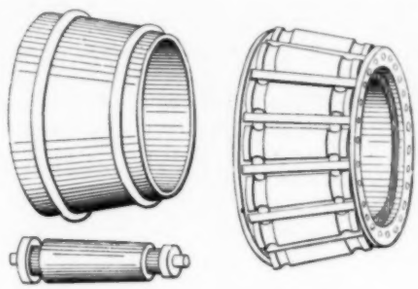


FIG. 7. ASSEMBLING ROLLERS AND CAGES

FIG. 8. RIVETING ROLLERS INTO CAGES

of ball support, and owing to the material's elasticity these lines are given an appreciable width, so that sufficient supporting area can be had with small-diameter rollers, and the roller-bearing outside diameter can be made very much less than that of the ball bearing to carry the same load.

It is also vastly less difficult to make true coned rollers than to make perfect



FIGS. 9 AND 10. CONE, ROLLER AND CAGE

balls, so that, in the board view, the roller bearing has commanding advantages both on the drawing board and in the workshop.

Side Play of Plain Rollers

The cylindrical roller cannot be made to give commercial bearings without side shake, hence the coned roller; and with the coned roller come cones and cone cups, and also some means for holding the cone rollers against end motion. The included angles of coned rollers in best practice vary from 3 to 4 degrees. No

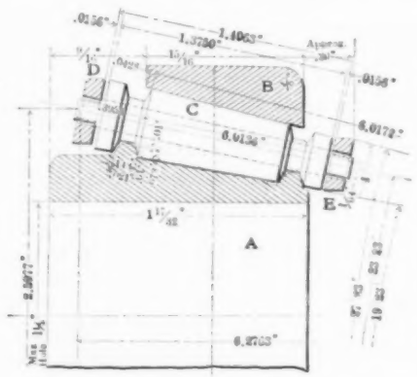


FIG. 11. DETAILS OF ROLLER AND CONE

standing load can cause coned rollers of such small angles to move endwise; but if the rollers travel, then they tend to creep outward, and the vital point of the cone-roller bearing is to prevent this.

All possible plans for keeping the roller in place by constraining agents applied at the roll ends have been tried and have failed, because the constraint of necessity retards the big end of the roller the more, and so tends to make this big end lag and thus throw the rolier out of parallel with the cup and cone and insure the speedy destruction of the costly cone-rolier bearing.

Holding Coned Rollers in Place

The method of holding the rollers used in the Timken cone roller-bearing is by grooving the rollers near their ends, and supplying the cones with ribs to co-act with the roller grooves, thus insuring equal roll retardation at each end of the roller, and so permitting the rolls to remain parallel in axis to the cone and cup, while certainly fixing the endwise location of the coned rollers themselves.

The Timken Roller-bearing Axle Company, Canton, O., is now running 450 hands, full double turn, 22 working hours per day, has a fine plant, several views being shown of their various departments in Figs. 1 to 8.

The cone roller itself is the feature of construction interest in the roller bearing, and the sequence-operation illustrations and descriptions here given are notable.

The Timken Plan

The Timken roller bearing is made up of the cup, or outside member, the roller assembly, and the cone. The roller assembly is made up of the rollers, two sheet-metal rings and the studs which unite the rings. The rollers have tits or "nibs" on their ends, which have a large clearance in holes in the cage rings. The cage studs are shouldered at each end, fit holes in the sheet-metal rings and are fixed by riveting.

Fig. 9 shows a Timken cone, with roller-retaining ribs, and also a roller, with retaining grooves and tits on the ends. The working bearing is the surface between the roller grooves.

Fig. 10 shows the cone and cage assembly.

Fig. 11 is a construction working drawing of a cone roller bearing. *A*, cone; *B*, cup; *C*, cone roller; *D*, outer cage ring; *E*, inner cage ring. The Timken cone rollers are not all the same included angle. This angle varies from 3 degrees to 4 degrees. The variations crept into the models at first, and have never been rectified so as to make the taper the same in all rollers. This is of no kinetic importance, but is a distinct factory-practice blemish, as each variety of rollers has to be made and ground to its own angle.

Fig. 11 is reproduced with all dimensions and references, and is from one of the regular construction sheets.

Fig. 12 shows a bearing for 1 7/16 diameter line shafting, very late construction.

The Working Program

The operation of roller making is in the following order:

(1) Making of the rollers from round stock, either machine steel or chrome nickel steel on screw machines.

(2) Rough inspection. Sorting over the work as it comes from the screw-machine boxes and rejecting those that are visibly imperfect.

(3) Converting by packing in carbonizing material, heating for 18 hours followed by slow cooling.

(4) Harden by heating in revolving gas furnaces and discharging the hot roller into oil tempering baths.

(5) Grinding the taper bearing surface of the rollers.

(6) Sorting. This is a second visual inspection, in which rollers not ground clean all over the load-carrying surfaces are sent back to grinder.

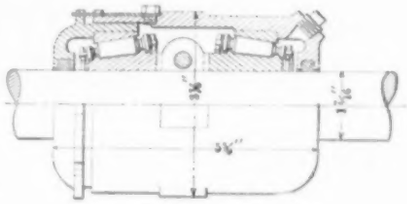


FIG. 12. SHAFT BEARING

(7) Gage with micrometer. Snap gages are used, open end pieces of hard steel, about ⅛ thick, which determine approximations to size, roughly. All rollers for any one bearing must gage close, say to within about 0.0001, as the rollers come from the grinding machines.

(8) Gage in solid receiving gage, and apply sheet-metal gage to pass over the roller tit, so as to be sure the rollers match up endwise with each other. This means that rollers are sorted with the receiving gage, a solid female gage, to

FIG. 13. MICROMETER GAGE WITH MULTIPLYING LEVER AND MAGNIFYING GLASS

within about 0.0001 limit of diameter variation at the inside edge of the large-end roller groove.

(9) Assemble.

(10) Rivet in riveting machines.

(11) Final inspection.

Material Used

The roller stock was specified as "special mild steel." A chrome nickel steel is now being introduced in these rollers, with 25 per cent. reduction of roller output from the screw machines, and greatly

increased toolmaking cost per roll produced.

There is a "physical" test for the carbonizing. Some eight or ten rollers are wired together and packed in the middle of each hardening box. Three of these out of each hardening box are broken, and have the fracture etched with acid to make the depth of carbonizing show to the eye of the inspector.

Complete bearings are also under continual running test in a special testing machine, in which a weighted lever presses two of four bearings applied to the same straight shaft toward the other two, bearing with three or four times the normal load for the bearing under test.

For horse-drawn vehicles the rollers are commonly assembled without grinding. The unground rollers do not feel quite smooth in the assembled bearing, but in the course of time they wear smooth.

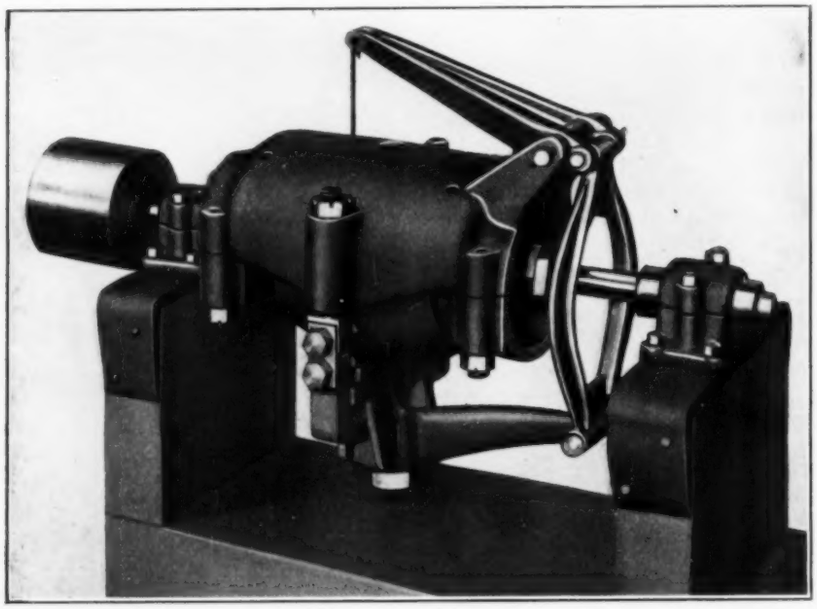


FIG. 14. MACHINE FOR TESTING BEARINGS UNDER EXCESSIVE LOADS

Drafting-room Economies

By Ralph A. Gleason

The following drafting-room methods will give a considerable saving over conventional practices. The economy will be in both material and labor, and while the results as far as the usual usefulness of drawings, that is, to manufacture parts from and to form records, are not all that could be desired, yet the drawings thus made will still serve their purpose, which is the main point.

Any method which will save repetition of work is a saving and particularly so when it saves many repetitions, also ease in handling and filing is a saving.

For the sake of comparison, I will first describe briefly the conventional methods.

Conventional Methods

You take the most convenient board and with thumb or copper tacks fasten on a piece of paper. You are in a hurry to show your own or others' ideas and after several days' work you discover that your board is too small and you must show another view on another sheet. When the design is completed, a detail for each piece is desired, so with pencil, scale, compass and sketch pad, a rough sketch is made with all dimensions, radii, etc., from which a detail drawing, tracing and print are made, during which processes, including the design, every dimension and radius has been scaled three times and every line for each part of the design has been made four times, viz.: in the design, the sketch, the detail and the tracing. At times, some of the above operations are omitted but for high-grade work all are customary.

Economical Methods

The design sheet should be thoroughly wet by dipping and then it should be glued by about an inch margin to a large board, then allowed to lie horizontal over night so paper and glue can dry. A sheet so treated will remain indefinitely taut so that all dimensions can be scaled accurately. Tacks of any kind are time wasters on all kinds of drawings. Paste is cheaper and quicker.

For details, instead of detail paper, procure cross-section paper or pad ruled to eighths of an inch and inches in light blue lines about the size of your small detail sheets for screws, studs, etc., and instead of tracing cloth, procure a good quality of tracing paper in rolls and cut this to the detail-sheet sizes. To make a casting detail, select a suitable-sized sheet and with a small dab of "library paste," paste each corner of sheet over part to be traced from the design and move sheet for each view. A smart draftsman with a soft pencil will trace most of it freehand. When part is delineated, put on the necessary machinist's dimension lines and border lines, then tear off the sheet carefully leaving small corners which may be easily removed. Then all dimensions can be transcribed accurately which is the second and last time necessary for those figures to be used by the draftsman.

The patternmaker's dimensions are put on in white on a blue-print from the paper tracing.

To make a steel detail, select a suitable size tracing-paper sheet for the part, and paste it over the cross-section sheet or pad by the corners. Take it to the design and with scale in one hand and soft pencil in the other, draw the part freehand, following the lines of cross section according to dimensions read, then fill in all dimensions the same way as for casting detail.

For some classes of machines, tracing paper is excellent to design on because of the ability to erase easily with most any of the soft erasers and to pin moving parts over each other to observe motions. Tracings made on a good quality of tracing paper with a 2H pencil will print well and not smear or tear in handling and can best be filed in envelopes the size of the middle-sized sheet.

The larger sheets, though being folded, will not break as tracing cloth does. The filing envelopes may be home-made of manila paper and are arranged like books on shelves with the corners marked for indexing which is better than the use of drawers because they can all be seen at a glance. The above-described method best applies to actual-size drawings or larger scales and one piece on a sheet, both of which points have many advantages. The old method may be resorted to in a case of expedience like reduced scale.

Some may think that this method is rough and impractical but they will find, upon consideration, that it is not necessary for all lines to be absolutely straight and all circles and semi-circles true because the intention is quite generally understood and all dimensions, radii, and notes are always worked to, and when correct are sufficient. The incidental time saving is apparent and the cost of material saving is the difference between ink, cloth and detail paper, and good quality tracing paper. An additional saving is the certainty of no spoiled records by accidental spilling of ink.

The New York surface car lines, with overhead trolley, cost $50,000 per mile.

Correcting a Drilling Jig

How an Accurate Job Was Done with Common Measuring Appliances and Without Expensive Rigging-up

BY WALTER GRIBBEN AND GUS WEINMANN

At page 615, Vol. 29, Part 2, W. A. shows how he fixed up his milling machine to do jig-construction work in a quick and accurate manner. In somewhat of a contrast to his methods, we show herewith another way of doing work of that character by means that were, to a great extent, improvised, as we did not expect to get any more work of the same kind, so could not afford to spend much on fixtures of a special nature.

The Job to be Done

A good-sized drill jig with about twenty holes, most of them in hinged lids, was returned by the parties for whom it was made as being defective in regard to the location of the holes. An error limit of 0.0015 inch had been allowed on the locations, which were measured from the planed edges of the jig body; but as the shop in which this jig was originally built was not properly equipped for this class of work, it was not surprising that some of the holes were out a trifle more than the specifications would allow. We undertook to correct the location of the holes and get them near enough to blue-print figures to pass the inspector; and as the jig has not been heard from since, the work we did was probably satisfactory.

The Facilities at Hand for Doing the Work

The facilities available for this reconstruction work were a Brown & Sharpe milling machine with vertical spindle milling attachment, standard surface plates, a 24-inch vernier caliper, a micrometer depth gage, a lathe indicator, and a surface gage, the stem of which was a flat bar.

Measuring the Jig to Find the Errors

The first thing to do was to force out all of the original bushings, and then measure the distance of each hole in the cast iron from two sides of the jig body at right angles to each other, which were used as datum surfaces. Fig. 1 shows how the indicator was clamped to the surface-gage stem and applied to the hole to be tested, the jig standing on one of its datum surfaces on the surface plate. As the surface gage was moved slowly from side to side, the hand on the indicator dial would move, and the reading on the dial would be at a minimum when the feeler was at the highest point in the hole. This minimum reading was noted and the indicator carefully withdrawn from the hole, after which it was transferred to another surface plate, as shown in Fig. 2, and placed under the movable jaw of the vernier caliper, the latter being then adjusted till the indicator read the same as it did when in the hole. Used in this way, the indicator was simply a comparator, to tell when two quantities were alike; and it was not necessary to rely on the graduations of the indicator dial as being correct.

After having adjusted the vernier jaw to make the indicator read the same as it did when in the hole, the indicator was carefully put back in the hole again to see if the minimum reading was still the same. This was done to guard against the possibility of anything having slipped while making the comparison. The reading of the vernier caliper, added to the distance *A*, Fig. 2, gave the distance of the upper side of the hole above the datum surface. The distance of the lower side of the hole above the datum surface was determined in a similar manner, and a mean of these two quantities, of course, gave the distance of the center of the hole from the datum surface.

When the lower side of the hole was tested, it became necessary to use the attachment shown in Fig. 3 for the movable jaw of the vernier caliper, as then the indicator feeler pointed downward. This was simply a piece of sheet brass lapped flat on the side next to the jaw, and held fast thereto by a clamp made of a short piece of brass tube with a nurled-head brass set-screw. The lower screw in Fig. 3 is to hold the parts together when they are not on the vernier jaw. One reason for making this attachment of brass was so as not to do any damage to the vernier caliper, which did not belong to us. Another reason was that the materials from which to make it were taken from the scrap box.

The vernier was made to stand upright and do duty as a hight gage by being clamped between two small angle plates that had been machined all over. The distance *A* was determined by a micrometer depth gage and was, of course, a constant to be added to all vernier readings when used either as in Fig. 2 or Fig. 3. Fig. 1 does not show the actual jig we measured and corrected, but a plain cast-iron block with a hole in it, which will do just as well to illustrate the principles involved, and is much easier to draw than the real thing.

After measuring in this way the distance of each hole from each of the two datum surfaces, we compared the measurements with the blue-print figures, and thus obtained the error or location of the holes as originally bored.

Enlarging the Holes and Correcting the Center Distances

The next thing to do was to bore out the holes a trifle larger, and move the center of each hole the amount of the error as previously determined. This was done by clamping the jig to the milling-machine platen and getting the vertical milling spindle in line with the original hole, after which the platen was moved the amount of the error of that particular hole, and the hole then bored out enough to get a cut all the way around.

Setting the Miller Spindle in Line with the Original Holes

The method of getting the vertical milling spindle in line with the original hole is shown in Fig. 4. *B* is the lower end of a ⅜-inch threaded milling arbor on which *C* is screwed. *D* is adjustable along *C* for different-sized holes, by means of the clamping screw *G*, which passes through an oblong hole in *D*. *H* is the dial part of the indicator, the short plunger of which bears against the top end of the lever *L*, and the bottom end of which bears against the circumference of the hole being operated on. *D* is really an angle piece, but is made of two pieces of straight stock screwed together, the screw heads showing in the plan view in Fig. 4. The apparatus shown in Fig. 4 for holding the indicator dial had to be made in a hurry and we had no time to wait for castings, so had to make it of straight stock.

By slowy rotating *B* the lower end of *L* would travel around the circumference of the hole, and any movement of the hand on the indicator dial *H* would show a want of alinement of the hole in relation to *B*. Then the platen of the milling machine was moved either lengthwise or crosswise, or both, as the case demanded, until no movement of the indicator hand took place during the rotation of *B*. When this was the case we were then sure the milling spindle *B* was in line with the hole as originally bored.

How the Longitudinal Shift of the Platen was Measured

After this the cross slide was moved an amount equal to the error of the hole in that direction, measuring the movement by means of the regular cross-feed dial; but we could not work the same scheme

for the longitudinal movement of the platen, because this machine was an old one that was not provided with a micrometer on that feed screw, and we did not care to make one for this job. The first scheme we thought of using was to place the proper leaves of a thickness gage under the bed stop, but this plan was abandoned in favor of clamping a regular bow micrometer to the under side of the platen of the milling machine, as shown in Fig. 5, and letting the back end of the screw come in contact with the saddle.

afford means for adjusting, we used this split to read against. It made a rather coarse line for that purpose, but by using a magnifying glass and using only one side of the split, we got along all right.

The Arbor and the Boring Tools

As the boring device and the indicator holder had to be used alternately for each hole, they were both made to screw on the same arbor, so the arbor could remain in the milling machine all through the alining and boring operations.

This ½-inch bar, shown in Fig. 7, had no way of feeding the cutter out for depth of cut, so we made the piece *P* out of sheet brass to be slipped over the end of the bar while adjusting the cutter, but removed it before the boring cut was commenced. For holes under ½ inch we used the boring tools from a bench lathe, held in split bushings in the piece shown in Fig. 6. These we had no way of setting for depth of cut, except by bending them with a hammer after they were clamped in place. This answered very well, as

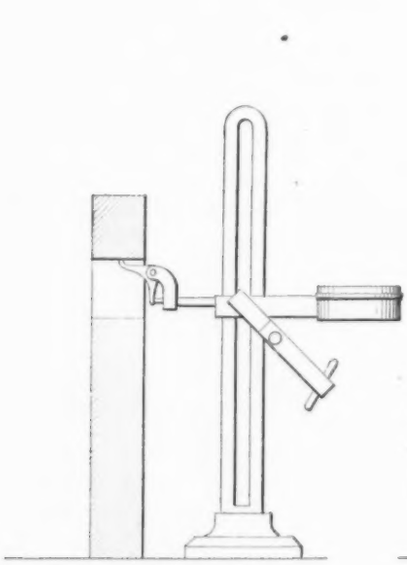


FIG. 1.
Measuring the Jig with Surface Gage and Indicator.

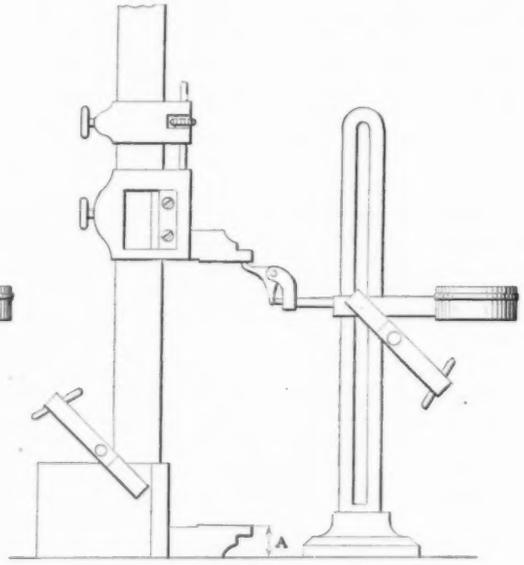


FIG. 2.
Getting the Dimension from the Surface Gage with a Vernier Caliper.

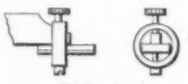


FIG. 3
Extension Contact Piece for Jaw of Vernier Caliper

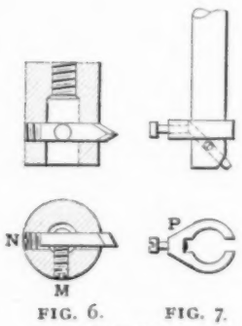


FIG. 6. FIG. 7.
Boring Tools.

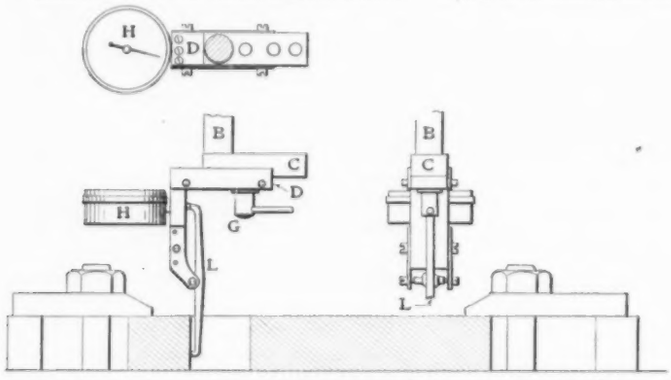


FIG. 4. Setting the Vertical Milling Spindle in Line with the Original Holes.

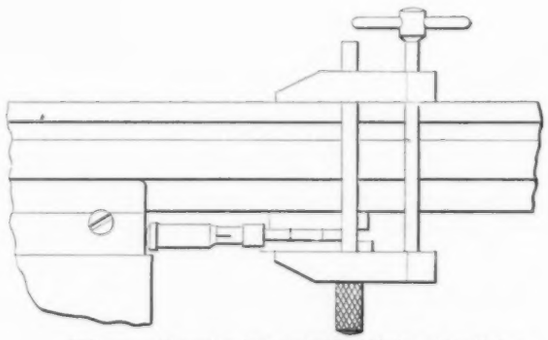


FIG. 5. Measuring the Longitudinal Motion of the Platen.

CORRECTING ERRORS IN THE LOCATION OF THE HOLES IN A DRILLING JIG

We did not use this micrometer itself as a bed stop, but had the regular bed stop on the other side of the saddle to hold the platen steady, both when the spindle *B* was in line with the original hole and also after the platen was shifted by the amount of the error in that direction, using the micrometer shown in Fig. 5 only to determine how much the platen had been moved.

When clamped in this position the reading line of the micrometer was hidden by the platen; but as the barrel is split to

The piece shown in Fig. 6 was made of a piece of 1⅛-inch shafting, the screw *M* binding the cutter, while the screw *N* fed the cutter out for depth of cut. This was used for the larger holes of the jig, while for holes too small for this, but over ½ inch, we took a ½-inch boring tool that had been made for the bench lathe, but had been superseded by a better one. We cut this off as short as the depth of holes would allow, and held it in the piece shown in Fig. 6 by the screw *M*.

there were only two holes that were under ½ inch. The scheme shown in Fig. 7 for setting out the cutter we think is original, and could be used to advantage on a boring bar held between lathe centers as well as on a bar held in a chuck.

After reboring the holes we measured all the locations again to see if the errors in our own work were any smaller than those of the other fellow, and were very much gratified to find that they all came within the prescribed limit of 0.0015 inch.

Finishing and Measuring the New Bushings

Of course, we had to make new bushings, as the original ones were now too small on the outside diameters. After hardening, they were held in a jaw chuck while the hole was ground, and then put on an arbor between centers while the outside was ground. We took precautions to have the outside and inside grinding concentric, but in spite of all our efforts some of the bushings had the wall slightly thicker on one side, but only a fraction of 0.001 inch.

After grinding, the bushings were tested by holding horizontally in the bench vise the arbor on which the bushing had been ground, and placing the bushing on that part of the arbor where it could turn freely but without shake, letting the bushing run against the side of the vise jaws to prevent endwise motion, and then letting the feeler of the indicator bear against the outside of the bushing while it was slowly turned with the hand. The indicator in this test was held as in Fig. 1, only with the feeler pointing downward.

When the bushing was found to be eccentric more than 0.001 inch, we threw it away and made a new one; but if the eccentricity was less than 0.001 inch, we marked the thick part of the wall and so placed it when forcing it home that it fell in the direction of the error of location of the hole in the cast iron. In this way we made two small remaining errors offset one another, to some extent, at least, whereas had we forced the bushings in at random, the law of the perversity of inanimate things would have located the thick part of the bushing wall just 180 degrees around from where it ought to go.

Two Chucks and a Drill Jig Used on the Dietzman Shock Absorber

The making of shock absorbers for dampening or retarding the action of springs on automobiles has grown into quite a little industry, and the making of the Dietzman device in their Hoboken shop has a number of interesting features.

A section of the absorber is shown in Fig. 1, in which the outer case carries the friction piece or spool *A A*, held in place by lock nut *B*, which gives the desired friction.

Between the heads of the spool and the case are fiber washers, and the annular recess *A* is filled with grease which works out to these washers through the small holes drilled through the flange, and shown by dotted lines, thus insuring an even friction between the lubricated surfaces.

The casting is peculiar in shape, but is machined without difficulty by first putting in a chuck and facing the surface *C* and boring the hole for the stem of the spool. Then it is put on a face plate, as in Fig. 2, where it is centered by a fixed pin *P*, which fits the hole and is held by a set-screw bearing on the flange, as shown. They can be chucked very quickly and accurately by this means, and the chamber bored and threaded square with the face *C*.

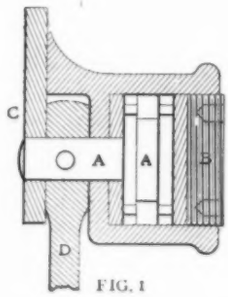


FIG. 1

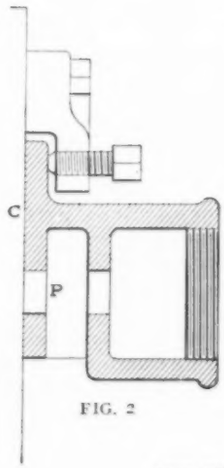


FIG. 2

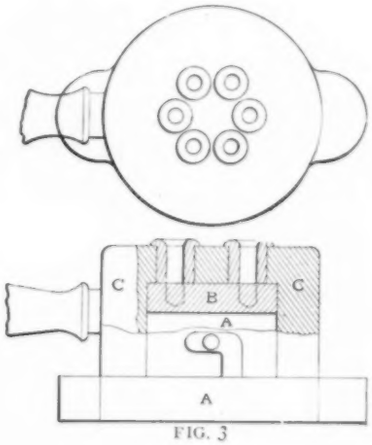


FIG. 3

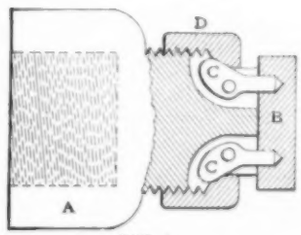


FIG. 4

TWO CHUCKS AND A DRILL JIG FOR A SHOCK ABSORBER

A Novel Drilling Jig

The lock nuts *B*, which are held from turning by a set screw not shown, are cut from a bar of mild steel and the six wrench holes drilled before being threaded. The drill jig, Fig. 3, is in two parts, the base *A A* extending up inside the outer case *C C*, above the bayonet joint as shown. The blank to be drilled, *B*, is laid on this, the cover or case *C C* dropped over it and locked by the bayonet joint.

After the first hole is drilled a pin is dropped into it, through the bushing, to prevent turning, and the rest of the holes drilled as usual. This secures even spacing without the necessity of making the jig itself clamp the nut tightly enough to prevent turning.

Holding the Nuts for Threading

These nuts are then taken to the turret lathe for threading and are held by the wrench holes on a chuck made something like Fig. 4. The chuck body *A* carries six hardened jaws which are pivoted in the body and are forced outward by the action of the cone nut *D*. So the blanks are simply slipped over the six jaw points, the points spread by nut *D*, and the thread is cut while we are talking about it. It seems like a rather weak construction, but it has been doing business for months, and that is the test that counts.

How it Works

A lever *D*, Fig. 1, fastens to the spool *A* and this connects with the axle or lower part of the spring, the casing being fastened to the body of the automobile. The action is a partial turning between the heads of spool *A* and the two fiber disks. They are adjusted to a pull of about 20 pounds at the end of the lever for a moderate-sized auto.

Mr. Dietzman tested one of these on a milling machine in a rather ingenious way by rigging a short crank on or in the spindle, to which he fastened the lever of the shock absorber, the body being fastened to the table. Then he started up the machine, without any back gears, and let it pump all day, to note the wear and the difference in friction. As the friction was a little higher at the end than at the beginning, he concluded that the wear had been practically nothing, the increase being due to expansion of the spool from heating. As the surfaces were thoroughly lubricated, this seems a fair conclusion.

The New York subway cost $2,150,000 per mile.

A Molding Job with a Green-sand Core

Description of the Core Box and the Method of Sweeping Up the Core by Which Much Time Was Saved

BY W. W. McCARTHY

If occasion should present itself for a visit to Atlanta, it would perhaps be interesting to molders to visit the Majestic Hotel in that city and take a look at the staircase surrounding the passenger elevator in that hotel; and it may be of interest to patternmakers also.

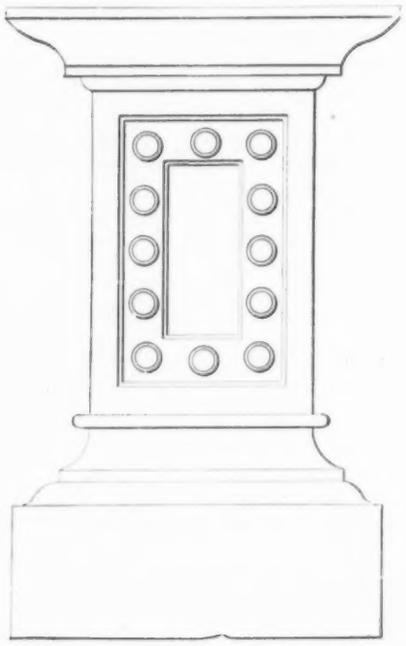


FIG. 1. NEWEL POST TO BE MADE

Fig. 1 represents the newel post at the stairway referred to, the molding of which is to be described herein; its dimensions are about as follows: base 7x15 inches; shaft, 12x12 inches; cap, 15x15 inches; hight, 40 inches; metal thickness, 3/8 inch. We are at a loss to define its exact style, but we will not worry about that, for it is very apt to perpetuate its own style for an indefinite period. Fig. 2 shows the pattern, showing the core prints at each end, also the method of gating and the bearings in which the core is supported, showing too that the parting line does not occur at the center as is usual in patterns of its shape, but occurs immediately at the two opposite corners; this will be further gone into as we proceed.

The Loose Panels on the Pattern

The four panels are doweled on with loose dowel pins which are withdrawn immediately after the drag has been rammed up to an inch or so above them; the object in ramming above the pins is to insure against any possible movement of the two panels in the drag. The dowel pins are withdrawn through the excess of sand at that point and this excess is tucked into the small opening left by the removal of the dowels; the process of ramming up the drag and "rolling it over" is then proceeded with. The two opposite panels come in the cope as a matter of course; they are treated in a different manner on account of the possible interference of the bars in the cope coming in contact with the loose dowels, thereby creating more or less annoyance in withdrawing them. Therefore all the dowel pins in the cope remain until the cope is lifted off; they are then drawn through the pattern in the manner known to molders as "backing them out." They could just as well be "backed out" in like manner in the drag, but there is no special occasion to do so because there is nothing in the drag to interfere; therefore it is up to the molder either to draw

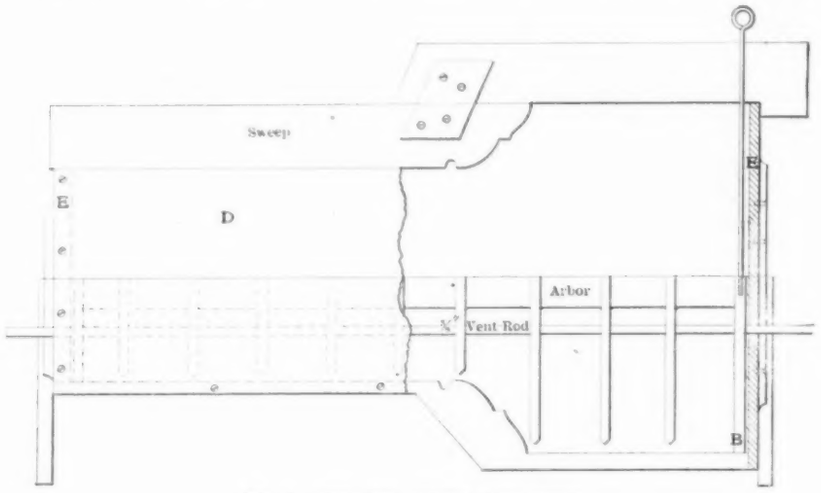


FIG. 4. CORE BOX, SWEEP AND ARBOR

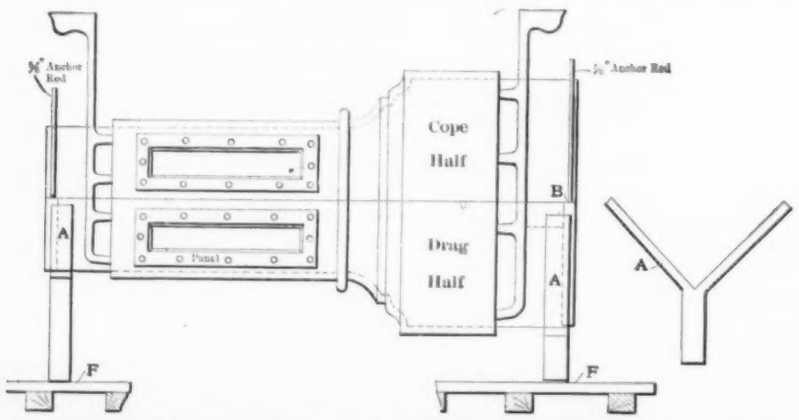


FIG. 2. PATTERN; SHOWING BEARINGS IN WHICH THE GREEN-SAND CORE IS SUPPORTED, SHOWING ALSO METHOD OF GATING

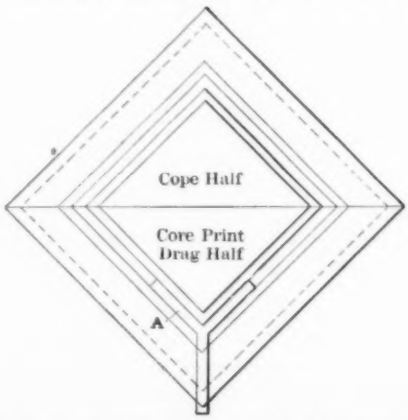


FIG. 3. VIEW OF PATTERN FROM SMALL END SHOWING PARTING LINE

them or "back them," just as he chooses, the pattern being "boxed in" or hollow, thus permitting free access to the dowels. Our reason for dwelling so much on the subject of dowel pins in this case is that it is exceedingly important, from the fact that if one of the panels shows a "shift" it will seriously impair the appearance of the job if not ruin it outright. Fig. 3 is a view of the pattern from the small end; this view is given for the specific purpose of showing the parting line. It further shows that the manner in which the core is "set" practically eliminates the danger of a crush in closing on the cope.

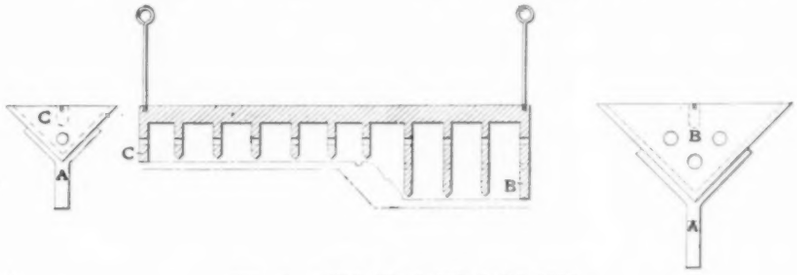


FIG. 5. ARBOR FOR GREEN-SAND CORE

The Core of Green Sand

Fig. 4 is the core box, in which the core is made of green sand. The side *D*, which is shown with one end broken off, and the other intact and held by wood screws, is to be removed, as we shall see later. There may also be seen the cast

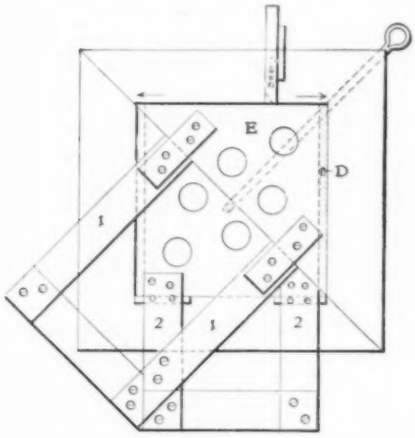


FIG. 6. VIEW OF SMALL END OF CORE-BOX

arbor and its position relative to the bottom of the box and the 5/8-inch vent rod passed through the entire length of the box. The sweep is also shown in this figure, and the bearings on which it travels are shown at each end of the box at *E*. The eye-bolt shown at one end is placed after the sweeping process has been finished and the boards *E* forming the upper half-ends have been removed. Two eye-bolts of equal length are employed in handling the core, a straight rod of sufficient strength being run through them parallel with the length of the core; the core is thus lifted out of the box and placed (or "set") into the mold previously prepared for it, resting in the bearings *A* and *B*. See Figs. 2 and 5. Fig. 5 represents the arbor on which the core is made. In following this method, we find that the green-sand core may be made and set into the mold in a considerably less length of time than that generally consumed in making it in dry sand, to say nothing of the time and expense of drying, jointing and otherwise handling it.

The Process of Making the Core

It would be well to go into a short synopsis of the method employed in making the core. Fig. 6 is a view of the small end of the core box. Similar letters refer to similar parts, and similar numbers appearing on the legs or supports refer to similar positions in which the box is placed in the two stages of ramming up and sweeping off the green sand. Thus the first position in which the box is placed is that shown in Fig. 6 resting on *1 1*. The arbor bears on the box at *B* and *C*, Fig. 5. The intermediate bars are then tucked up to the openings, as shown, for vent rods. The vent rods are then put in their places through the arbor, six vent rods being used in the entire core. The movable side *D* is then placed in position and the wood screws are rammed down. The whole is then rocked over in the direction in which the hands of a watch travel, so as to rest on *2 2*. Fig. 7 is a view of the large end of the box, showing the travel of the sweep at that end. It will, of course, be understood that the reason the rocking to rest on the second pair of supports *2 2* in this view is virtually counterclockwise and opposite to that in Fig. 6 is because the box is now viewed from the opposite end, the direction of rotation being actually the same. By this rocking over we obtain a horizontal plane at the top and the process of "sweeping up" that side of the core as it appears in the box is proceeded with, the sweep traveling on the edge of the boards *E* in either direction, as indicated by the arrow points. The whole is then rocked back on to supports *1 1*, the side *D* and the two upper ends *E* are removed, a rod of sufficient strength is run through the eye-bolts, and the core is transferred from the core box to the mold and rests in the Y bearings, which in

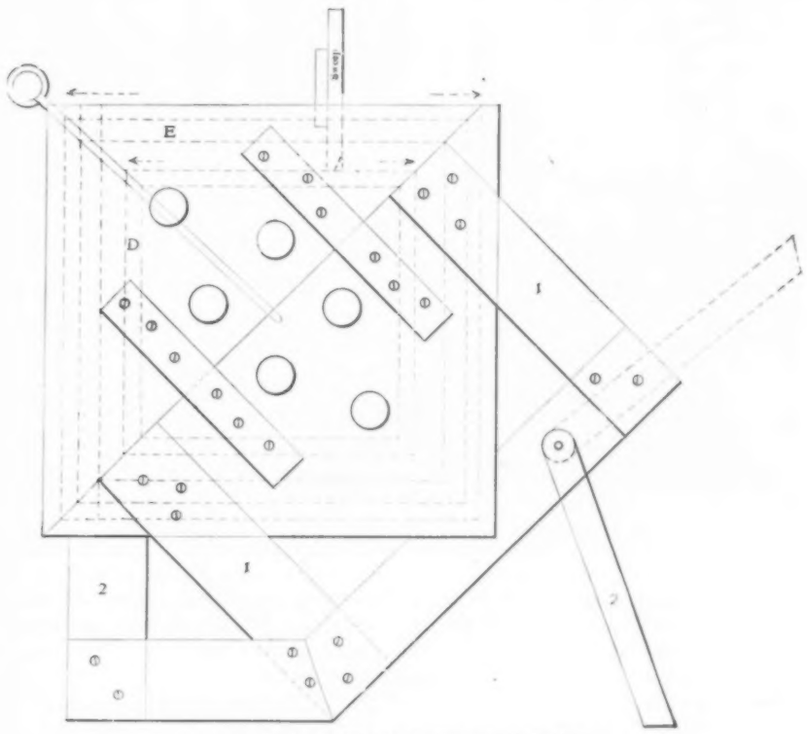


FIG. 7. VIEW OF LARGE END OF CORE-BOX

their turn rest on the bottom board *F*, as shown in Fig. 2. The cope is now closed on and the two 5/8-inch anchors are "wedged down" at *B C*, Fig. 2, and the mold is secured (clamped up) and made ready to receive the metal.

Several big nuggets of gold have recently been discovered at Poseidon Rush, near Taraguella, Australia. Two were unearthed weighing respectively 373 and 967 ounces.

Dedication of the Engineering Building

Description of Mr. Carnegie's Great Gift to the Engineering Societies and an Account of the Impressive Dedication Exercises

During the past twenty years, the project has been frequently discussed and agitated of bringing together in one building, with proper facilities for offices, library, auditorium, meeting rooms, etc., the various engineering societies that make their headquarters in New York City.

In February, 1903, Mr. Carnegie, as one of the contributors to the library fund of the American Institute of Electrical Engineers, was invited to attend its library dinner, and after four declinations on account of inability to arrange a date, accepted. The dinner was given on February 9, at Sherry's, when Mr. Carnegie spoke on co-operation among engineers. The president of the institute told of its growth and the need of a building for engineering societies. The next day Mr. Carnegie sent for C. F. Scott, president of the institute, and C. W. Rice, chairman of its building committee, and discussed with them the idea of a union engineering building. His attention was called to the fact that the Engineers' Club had just secured land for a new house in West Fortieth street, opposite the new Public Library. The locality appealed to Mr. Carnegie as highly suitable, and on February 14, he wrote a brief letter saying:

"It will give me great pleasure to give, say, $1,000,000 to erect a suitable union building for you all, as the same may be needed."

One year later, March 14, when the plans and estimates showed that a larger sum would probably be required to carry out the work on an adequate basis, Mr. Carnegie, in a further letter addressed to the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the Engineers Club, increased his sum to $1,500,000 in their joint behalf.

The only limitation on the gift was that it should be devoted to the erection of a building, the bodies interested buying the land. At the outset it was proposed to put up one building on Fortieth street, but owing to the difficulties involved in the purchase of as much land as would be necessary, and in combining under the one roof all the social and technical functions exercised by these organizations, it was decided to erect two separate buildings, one for the club on Fortieth street and one for the three professional societies on Thirty-ninth street, the two buildings to be placed in such relationship and contiguity that access from one to the other would be easy, and the underlying common purpose thus be subserved to the full extent.

The Site

The site acquired for the Engineering Societies Building is on West Thirty-ninth street, north side, between Fifth and Sixth avenues. The frontage covers five city lots, Nos. 29 to 33, the total front being 125 feet. This land has been bought with money advanced by Mr. Carnegie through R. A. Franks, to the three engineering societies at 4 per cent. interest, the cost being $502,000, one-third of the amount being payable by each society. To the east of the property, light and air for the building are satisfactorily insured by the purchase by the club for its own protection of a large four-story private house of "restricted" hight; the club being in the immediate rear of the Engineering building.

The Building

The frontage of the Engineering Societies Building, on West Thirty-ninth street, is 115 feet, and the depth is 90 feet. The property itself is 125 feet front by 110 feet depth. The building laws of the City of New York require that only 85 per cent. of the lot area shall be occupied by the structure on it. Advantage has been taken of this limitation to give the building a monumental appearance. It is designed in the French style and rises 13½ stories above the sidewalk to a hight of 218 feet 6½ inches. The exterior is built of limestone up to the auditorium floor, and of gray mottled brick and terra cotta above; the whole having a cheerful cream tint on all four sides. The treatment is restrained and dignified, but without severity. As the lower portion is devoted to auditoriums, the middle section to offices, and the upper part to the library, an effort has been made to accentuate these three separate parts of the building, with happy result.

Access to the building is gained by the central entrance on the street level to the first floor, by the western side door leading to the elevators, and by the broad driveway which encircles it completely, so that carriages can enter by the eastern covered arch, set down their occupants at a side entrance and emerge by the western gate. There are three elevator riseways in the main elevator shaft, faced with an iron grill lined with wire glass. On each side of this shaft wide stairways rise to the sixth floor of the building, and one leads thence to the library floor. A freight elevator has been installed on the eastern side of the building and a commodious service stairway on the north side rises the entire hight of the edifice. At the first floor a rear door communicates across the 10-foot areaway, in the open, with the café of the club-house, and on the ninth floor a flying covered bridge connects with the breakfast room on the tenth floor of the club.

The woodwork in the building has been reduced to a minimum. The large windows are built of cast iron and the other windows of wood covered with kalamined iron, such windows having only a small molding in place of the usual wide trim and casing. All the doors in the basement, first floor and at the ends of the auditorium promenade are kalamined iron fire doors, and the exit door to the Engineers' Club is built of electroplated copper on wood. All the woodwork, including floors, sleepers, trim, etc., has been fire-proofed. The windows up to the hight of 100 feet are glazed with wire glass, except on the Thirty-ninth-street front, thus bringing the exterior fire hazard down to the lowest point. All finished floors throughout the building are of cement, marble or terrazzo, except the library, main auditorium and lecture rooms, where maple has been used. The insurance rate of 15 cents for this building is the best proof of its safe construction and solid workmanship. Moreover, additional precaution against fire has been taken by placing an 8000-gallon tank on the roof, with a stand pipe at each end of the building, the tank being fed by two electric pumps.

All the walls and ceilings are painted in neutral tints, and the decoration is simple though carefully studied, especially with an idea of later development in the way of mural paintings, the setting of the names of distinguished engineers in plaques, niches for bronze or marble busts, panels for bronze tablets, etc. Opposite the elevator shaft on each of the three founder societies floors the badge of the society occupying the floor has been executed in a heavy brass plate set in the terrazzo. The hardware throughout is in a subdued brass finish, is quite massive and is master-keyed for all doors. The mail chute is ornamental and of the latest pattern. The driveway is defended by handsome wrought-iron gates specially designed, and over the main entrance a large bronze plaque has been set, bearing the words, "Engineering Societies," to explain the purpose of the building to passers-by.

First Floor

The spacious first floor is laid with Tennessee marble tile, having a border in de-

sign of colored marble. The central court or main foyer is marked by 12 large columns of Swiss Cipolin marble. A short low flight of steps leads from the foyer to the elevators, and at will a metal grille is thrown across the steps so as to restrict or direct travel. Gold ornament is used sparingly for achitectural accentuation and the wood work is in dark oak. Large chairs and lounges in red leather furnish the foyer, and similar furniture is used in the writing room, smoking room, reception room and administration room, which also contain three telephone booths associated with the private-exchange system. On the foyer walls, facing toward the main entrance, are two large bronze tablets, one bearing a relief portrait of Mr. Carnegie and the words of his second terse letter of gift of $1,500,000, and the other a statement to the effect that the land was given by members and friends of the three founder societies. On this floor also, at the rear, are receiving and shipping offices through which all freight and goods are handled. In time this floor will be graced with statuary, but even now it creates a most favorable impression as one enters the main building.

THE ENGINEERING SOCIETIES BUILDING, LOOKING WEST ON THIRTY-NINTH STREET

A CORRIDOR OF THE ENGINEERING SOCIETIES BUILDING

The Main Auditorium

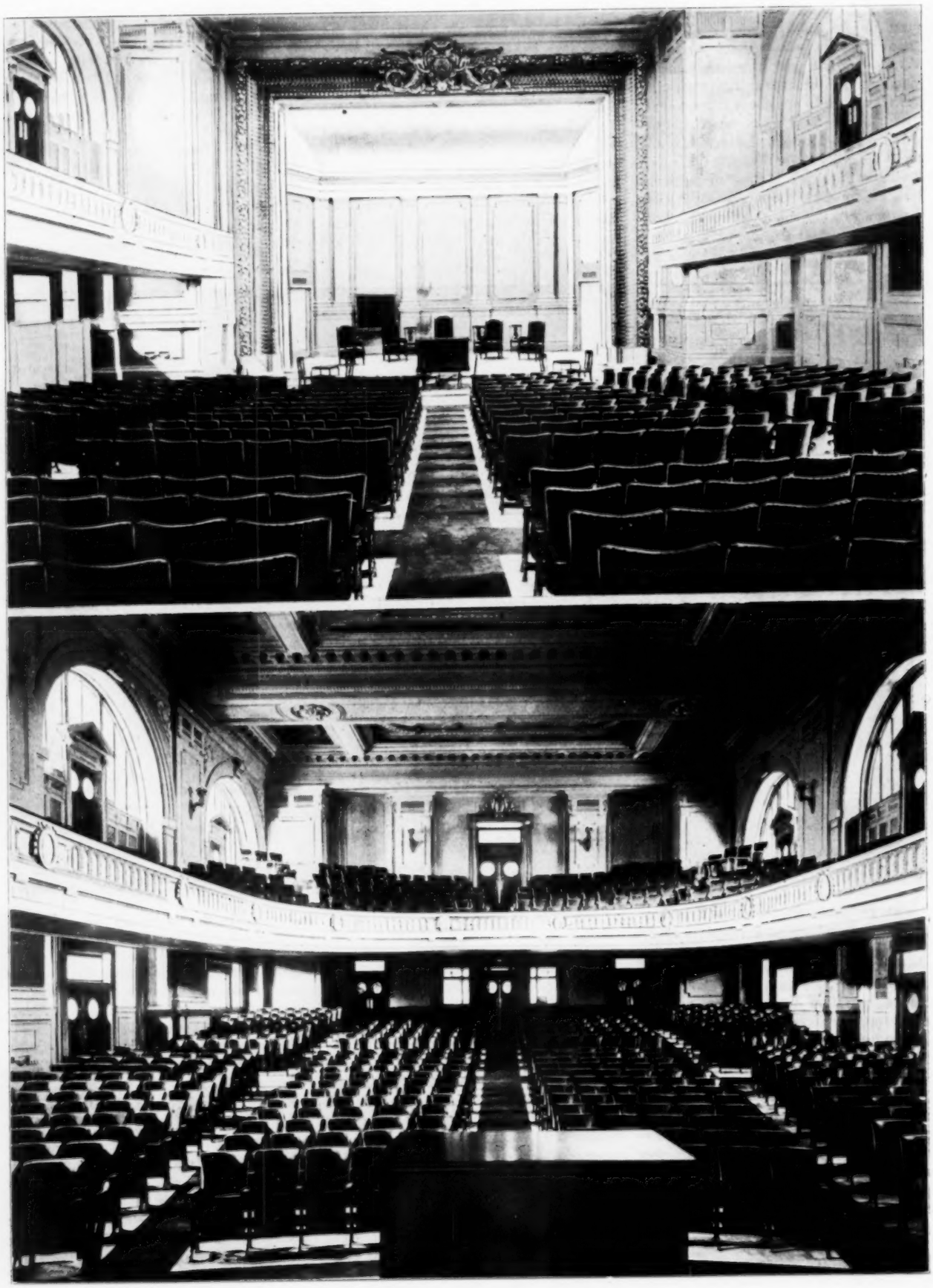
Immediately above the first floor is the coat room, laid out on a sectional plan so that several lines of persons may be accommodated at once on entering or leaving. Special toilet facilities are also provided on this floor, which virtually occupies the space that would otherwise be left blank by the slope of the main auditorium floor just above it.

The main auditorium extends up through two floors, and with its gallery will seat about 1000 persons. The requirements of this chamber were unusual and difficult of definition. It had to be arranged primarily for the general meeting of the societies, at which the speaking is from the floor as well as from the platform, and at which diagrams, illustrations or blackboard drawings are often employed. This is quite the opposite from the ordinary audience hall, where the stage is the starting point both for the seating arrangements and for the acoustic and optical necessities. Hence the platform is notably small for so large a hall, accommodating few persons, while any speaker in the audience is easily within range of observation by everybody.

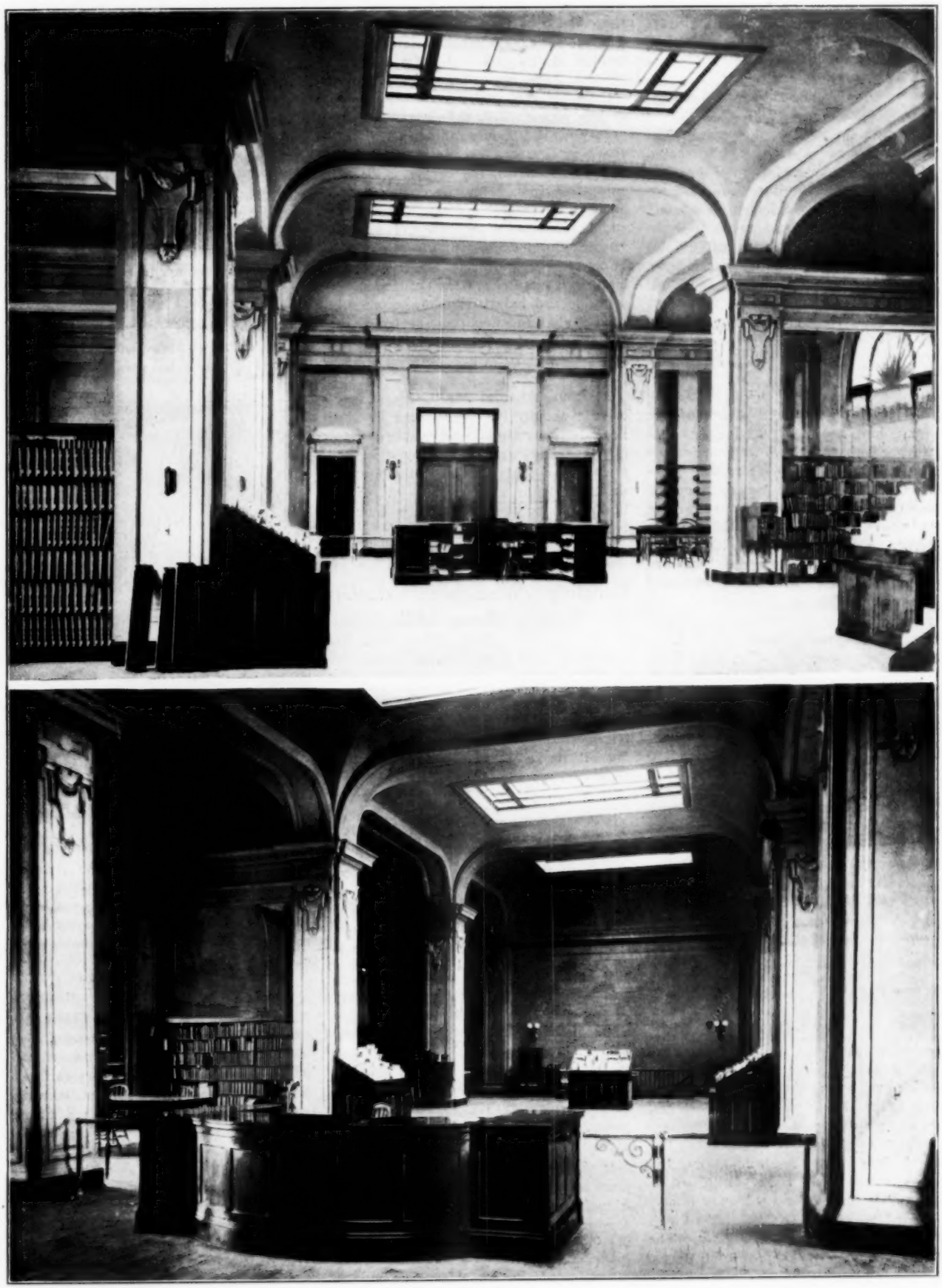
On both, the parterre and the gallery floor, at the sides the auditorium is surrounded by corridors, rendering access to every point very easy, and permitting ready withdrawal for conversation, committees, etc. The corridors assist also in maintaining quiet within the hall. The platform has ante rooms, and is conveniently close to the freight elevator, for delivery of apparatus. There is also a fine stereopticon equipped with connections for moving pictures. The seats are fixed opera chairs in red leather, with revolvable tops, and the aisles are laid with red carpet. The gallery front is bordered in red plush. Above the auditorium arch is a decorative cartouche bearing the badges of the three founder societies. There are side brackets for lighting, but the main illumination is effected indirectly through the glass ceiling, above which are incandescent lamps controlled from several panel boards. The elevators and stairs open directly upon the two floors of the auditorium which can thus be emptied very quickly in case of emergency. Practical tests of the chamber have already shown it to be a success in every respect of comfort and convenience.

The Lecture Rooms

The next two floors above the main auditorium are devoted entirely to lecture rooms, of which there are no fewer than seven. Two spacious assembly rooms, 51 feet by 66 feet and 29 feet by 66 feet, occupy the larger part of the fifth floor in such a manner that they can be used independently, or one may be made auxiliary to the other. Two smaller rooms on this floor, 16 feet by 22 feet and 18 feet by 19 feet, can be also used separately or as annexes for reception or



THE MAIN AUDITORIUM



THE LIBRARY

conversazione purposes, and provision is made with steam tables, etc., for the service necessary for luncheons or light refreshments. All these rooms are agreeably finished in soft light tints and have facilities for water, air, electric connections, etc., for demonstrations and experiments.

The sixth floor is also divided into lecture rooms, planned somewhat differently, and of smaller dimensions than those on the floor below. The dimensions are respectively 22x44 feet 6 inches, 30x46 feet 6 inches; 30x41 feet and 20x28 feet. In this manner, the building affords facilities to audiences of every size from 1000 down to 100; while on occasion every room can be occupied by sections and sub-divisions of an engineering or scientific meeting, with independence and without interference.

The Office Floors

The seventh and eighth floors of the building have been reserved for the associate societies that have engineering or some department of science as their principal object. For these organizations the building affords office areas of varying size, from one room up, with the common facilities of the lecture rooms, library and other accessories. Among these societies may be enumerated the Society of Naval Architects and Marine Engineers, the Society of Heating and Ventilating Engineers, the National Electric Light Association, the Society of Chemical Engineers, the New York Electrical Society, the Association of Edison Illuminating Companies, the American Street and Interurban Railway Association.

Founder Societies' Floors

Each of the three founder societies occupies a floor laid out in accordance with its own plans. The American Institute of Mining Engineers has the ninth floor, the American Institute of Electrical Engineers has the tenth floor, and the American Society of Mechanical Engineers has the eleventh floor. These floors are all devoted to administrative and executive work, and the libraries of the three societies have been concentrated in the two top floors of the building.

The Library

A crowning detail in the plan of the building has been the reservation of the twelfth and thirteenth floors for the libraries of the three founder societies, and of such other collections of engineering literature as may be added. The twelfth floor below the library proper has been devoted to the book stacks, but at the present time the main library is also equipped with one tier of stacks, with provision for a gallery tier later. The stack room is partly equipped with stacks, and in the library a delivery desk, reading tables and chairs have been provided. The founder societies entertain the ambition of creating and maintaining the finest collection of engineering literature in the world, supplemented by the current periodicals, and all the patents relating to invention in the arts and sciences. Provision is being made for special research accommodation, working alcoves, photographic reproduction, drawing and similar library work. Commanding magnificent views of Greater New York and vicinity in every direction, the library is retired, quiet, free from noise and dust, an ideal haunt of the student and man of research; while open at all times to any reader. In view of the proximity of the new public library, the Engineering Societies building, with its unequaled collection of scientific and industrial data, becomes at once a vital and important center of the highest value for the diffusion of useful knowledge, and the two libraries supplement each other.

A bronze bust of Mr. Carnegie, executed especially for the building by Mrs. E. Cadwalader Guild, a well known sculptor, from sittings, and presented by the present and past officers of the founder societies, stands at the eastern end of the library, facing toward the main entrance from the elevators.

(*Continued on page 610*)

Grinding Automobile Cylinders on a Boring Mill

By R. E. Marks

The finishing of machined work by grinding struck the new automobile shop last month, so after cussing and discussing all the whys and wherefores, they rigged up a double-headed vertical boring mill to do the trick.

They took the spindle out of one head, made a good, stiff grinding spindle with a long babbitted bearing to go in its place and drove this by a motor hung on a convenient beam.

The cylinders were clamped to the table and bored nearly to size with the boring head, then this was moved out of the way and the grinding spindle brought into play.

But It Didn't Work

To make this a good story I ought to be able to tell you how a single cut with the emery wheel left the bore just to size within one ten-thousandth or less, how it was perfectly round and exactly uniform in diameter from end to end.

But it wasn't.

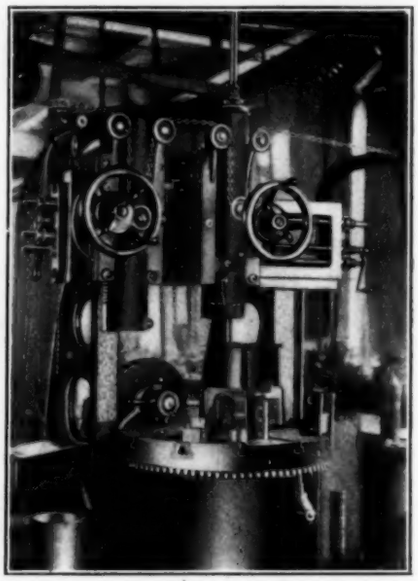
It wasn't round probably because there were soft spots in the iron; and it wasn't of uniform diameter, because the wheel would wear enough to affect the diameter very materially in one passage through the cylinder.

Being Frank with Yourself

My friend of the grinding operation is one of the most open-minded of men, and his frankness extends to himself as well as others—which is a rarity. He told me it made as pretty sparks as he ever saw, and that the cylinder looked nice, but it wasn't as good as they could bore it, and that is what they are doing now.

He even let me take a photograph of the whole rig as an example of how not to finish cylinders, and here it is. Probably others will try it, and he hopes they will have better success—can't have much worse—and he intimates that while they will find that much depends on the kind of wheel used and that the best of them are not good enough to make a good job, that probably isn't the fault of the wheel either.

In other words, my grinding friend doesn't think we know enough about the internal grinding of cast iron to brag about and intimates that it is possible we might know even more about rolling a finished surface on cast iron, as well as on car axles.



GRINDING AUTOMOBILE CYLINDERS ON A BORING MILL

Let Castings Adjust Themselves

Aside from the tapering cylinders due to wear of the wheel during passage, I am inclined to believe that the best cylinder boring must be done in two separate settings, with a fair time allowance between, so the casting can relieve itself of internal strains before the finishing cut is taken.

It is also a question as to how fine a finish you want in a cylinder. They should undoubtedly be as round and of as uniform diameter as can be had, but I very much doubt whether a ground surface is desirable even in automobile work. It certainly is not in steam-engine cylinders of either stationary or locomotive types.

The Development of a Card Index System for General Information

By Geo. P. Pearce

As master mechanic of a large firm composed of several factories I found need of some system which would keep costs, formulas, data tests, etc., in such shape that instant reference could be made. Problems and questions were constantly arising which required reference to previous records or data and they were of the most varied kind imaginable.

"Some more of that soft metal for impressions is needed; will you please give me the formula?"

"See! that was about last July when we experimented with those soft alloys." While getting out the list of formulas the phone bell rings and "the office" wants to know the present cost of steam per 1000 pounds. It was two weeks ago when we ran our last test and the results have to be looked up. In the meantime the bill has been received for the lumber used in extending the pattern shop and wants checking against the carpenter's list; then the new force pump to supply Factory No. 2 with water, wants ordering and the capacity has to be figured out from data collected at various times as to the maximum and average consumption of water in the various departments. While this is being done I find need for the production chart for department 300 for last August, also the cost and capacity of the No. 3 clip die; besides this a drying room is needed for No. 800 department which must have a capacity 50 per cent. greater than their output for period ending December 30. Thus it goes, data, records, charts, costs for various departments and machines are wanted constantly and if much time is going to be lost looking them up then the day will soon turn into a prolonged search for information to the exclusion of all other important matter.

The Alphabetical Plan

The first effort at systemizing was to file all information in alphabetical order, but that soon proved a hopeless failure. For instance, after testing the maximum speed that a new forming die will make clips it became a question where to file this data. Should it be placed under Dies, Clips, Capacity or Output? and no matter where it was put it was sure to be looked for under some different heading and then as we have hundreds of dies in the various departments and factories it would still take longer than practicable to find the required record.

From this came the bright idea of having a separate alphabet for each factory and this worked along in a bad enough way until the accumulation of live data (All "dead" matter is destroyed whenever fresh data is added) became so great that either the alphabet must be subdivided or else the method changed and a separate alphabet used for each department. Still the alphabetic system was unsatisfactory anyway, so a new system was planned which promised great results. All data, information, etc., was to be numbered consecutively and filed. Then 3x5 cards were made out under the various possible headings and filed alphabetically. Thus no matter under what heading information was looked for, it was sure to be found.

We got along with this nicely for a short time, but the time and trouble making out from one to four 3x5 cards for every piece of matter filed soon made it obvious that the method was doomed to failure, so I started to worry out something better and finally evolved the following system:

The System Adopted

The various factories were divided into departments which totaled up to 13 altogether; these I took and numbered as follows:

Machine shop	100
Carpenters shop	200
Pattern shop	300
Die shop	400
Power, Fac. 1, 2, 3, 4	500
Boilers, Fac. 1, 2, 3, 4	600

and so on all the way down to Forge—1300. All this I wrote down on a 6x4 card as the Main Classification. Next I divided each department on a series of thirteen 6x4 cards as shown in Table 1, which shows the first division of the machine shop.

Then I divided each of these cards into a second division, see Tables 2 and 3, which shows division of 110 or Machine Shop Costs, and 120 or Machine Shop Mechanical. The first and second divisions of each department were kept alike as much as possible, the exceptions being that some of the divisions were carried to higher numbers to cover something special in certain departments. Next I obtained some common letter folders and a vertical letter-filing cabinet, in which all data, costs, information, etc., after being numbered according to the divisions they belong to, were filed in similar numbered folders, which were kept in numerical order.

Does Away With Cards

By this system there are no cards to make out whenever anything is filed, nor are there any cards to be picked out when "dead" matter is destroyed; there is never any doubt as to where anything is to be filed nor as to where it is filed, and in a short time the position of anything in the file can be located without reference to the classification cards. For instance, if I want to know what the cost of extending the pattern shop was, I would find it this way—Pattern Shop—300, costs are always 10 and additions 2, so the particular information wanted will be in folder No. 312. The speed of shafting and size of pulleys in the die shop will be found in folder No. 425. Die shop—400, Mechanical—20 and Data—5, and so for everything else.

This system appears to be the simplest, most rapid and most efficient I have ever seen; it can be applied to any business, large or small, will grow to any extent, departments can be added or removed without trouble and if through any cause one particular number, or folder, happens to accumulate data to an inconvenient extent then that number can be still further divided into ten parts by using decimals, thus:

125.1 Machine Data. 125.2 Electric Data. 123.3 Small Tool Data, etc., thus giving unlimited expansion.

100 MACHINE SHOP.

Costs	110
Mechanical	120
Power	130
Heat	140
Light	150
Charts	160
Experimental	170
Product	180
Communication	190

TABLE 1.

110 COSTS

Repairs	111
Additions	112
Duplicate parts	113
Alterations	114
Machines	115
Material	116
Power, Heat, Light	117
Product	118
Estimates	119

TABLE 2.

120 MECHANICAL

Repairs	121
Additions	122
Duplicate Parts	123
Alterations	124
Data	125
Machine Records	126
Work records	127

TABLE 3.

The growth of the summer session at our various universities and colleges is well illustrated by the 54-page pamphlet which we have just received in which is outlined the work offered at Cornell University during the coming season. The work outlined includes education, ancient and modern languages and many branches of science, in addition to the shop, drawing office and other lines of work connected with the department of mechanical engineering. The pamphlet may be obtained by addressing the Registrar of Cornell University, Ithaca, N. Y.

It is estimated that a ton of domestic refuse will make 100 pounds of alcohol, which will give 100 brake horse-power-hours in a good motor.

The Thrust of Twist Drills

By Henry Hess

That's a thing I always wanted to know more about than I did or could find that anybody else did.

The report in the American Machinist, at page 210, of Messrs. Frary's and Adams' experiments, was therefore just what I had been looking for, and came at a particularly opportune time, when the selection of ball bearings for drill thrusts happened again to be on the carpet.

A Diagram and a Formula for Thrusts

When the editor said that just the one table of all of interest from my point of view at the time did not lend itself to a reduction to diagrammatic form, I was first disappointed and then skeptical. A little work showed that this relation of the thrust, diameter of drill and feed could be shown on a diagram and therefore also reduced to the formula:

$$T = (D + 12)\ \ (2000f + 20) - 250$$

T = thrust in pounds;
f = feed per revolution in inches;
D = diameter of drill in units of 1/16 inch.

In the main diagram there were plotted the tabular values (see table, page 211) for the smallest and largest and two intermediate feeds. These showed at once that the thrusts for the 9/16-inch drills with 0.0225 inch and 0.0156 inch feed were very high, as compared with the others; less attention was therefore given these in laying in lines that roughly averaged the various values.

The Method of Plotting and Obtaining a Formula

Possibly the method of plotting for the derivation of the formula may prove of interest. A few trials soon showed that the various diagonal lines trended toward a common intersection, which, however, lay in neither the vertical nor horizontal coördinate axes, but at a point which was ¾ inch, or 12/16, to the left of the vertical axis or zero line of diameters, and 250 pounds below the horizontal axis or zero of thrusts. The various lines could therefore be expressed by an equation of the usual general form for a straight line:

$y = cx + b$, in which
y = the vertical value, measured in pounds;
x = the horizontal value, measured in sixteenths;
b = the Y-intercept, or y value measured on the Y-axis when $x = 0$.
c = a coefficient depending upon the slope of the line (which in turn depends upon the feed) and including also a factor, 50, expressing the ratio adopted in this diagram between the vertical and horizontal scales.

We can eliminate the intercept b by transforming our coördinates to a parallel pair of axes with the origin or zero point at the common point of intersection of the diagonal lines, so that, as usual in such a case, for y we write $y + 250$, for x we write $x + 12$, and the equation becomes:

$$y + 250 = c\ (x + 12), \text{ or}$$
$$y = c\ (x + 12) - 250;$$

or, if for the vertical values we write the thrust T, and for the horizontal values the diameter in sixteenths D (so that, for instance, ⅝ inch is written 10), we have:

$$T + 250 = c\ (D + 12), \qquad (I)$$

or

$$c = \frac{T + 250}{D + 12}.$$

Finding a Value for the Coefficient in the Formula

In this insert known values of T from table for feeds of 0.0225, 0.0156 and 0.0045,

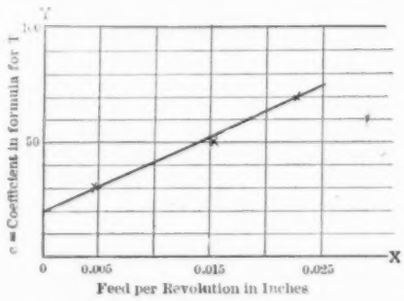


Fig. 1. Diagram used in deriving value of coefficient c

and $D = 14$ (a ⅞-inch drill), and we get:

$$c = \frac{1543 + 250}{14 + 12} = \frac{1793}{16} = 69$$
for $f = 0.0225$;

$$c = \frac{1110 + 250}{14 + 12} = \frac{1360}{26} = 52.3$$
for $f = 0.0156$;

$$c = \frac{529 + 250}{14 + 12} = \frac{779}{26} = 30$$
for $f = 0.0045$;

Now plotting these values of c (see Fig. 1) with relation to the feeds gives a straight line corresponding to the general equation:

$$y_c = k\,x_f + e, \qquad (II)$$

in which

y_c = vertical value = coefficient c, corresponding to
x_f = horizontal value = the feed; and
e = Y-intercept.

The diagram Fig. 1 shows that $e = 20$, that being the distance above zero intercepted on the Y-axis by the plotted line. For feed $x_f = 0.0156$, $y_c = 52.3$. Inserting these values in formula II:

$$52.3 = k \times 0.0156 + 20, \text{ hence}$$

$$k = \frac{52.3 - 20}{0.0156} = 2070, \text{ say } 2000 \text{ in even figures.}$$

Inserting this value of k in II gives $y_c = 2000\ x_f + 20$, or, getting away from the diagram, Fig. 1,

$$c = 2000\ f + 20.$$

Inserting this in equation I gives:

$$T + 250 = (2000\ f + 20)\ \ (D + 12), \text{ or}$$
$$T = (D + 12)\ \ (2000\ f + 20) - 250.$$

Some Remarks Upon the Formulas

This is of course an average value only. Inspecting the main diagram shows that, of the plotted points, the thrust for a 9/16-inch drill at 0.0225-inch feed varies most; it lies above the line 425 pounds, while the line average is about 1100 pounds, a variation indicating the average as $\frac{425}{1100}\,100 =$ 38.6 per cent. too low. But taking the other plotted points into consideration shows that this one high one was erratic and may therefore be disregarded; the other points show a variation of about 16 per cent. minus to 13 per cent. plus, so that we may with reasonable accuracy say that the diagram and formula are correct within ± 15 per cent., within the conditions of the experiments.

A formula may be similarly derived for the relation of the moment to the drill diameter and feed, basing this on the diagram on page 210. It is $M = (F + 2.5)$ $(13.66\ D - 0.25)$.

The averaging lines of the plotted data do not quite agree with those of the published diagram, but the variation is immaterial. In this

M = driving moment in inch-pounds;
F = feed in thousandths of an inch per revolution; thus an actual feed of 0.010 is called $F = 10$.
D = drill diameter in inches.

[For convenience of reference the diagram of turning moments is reproduced from page 212 alongside of the thrust diagram.—Ed.]

Tax on Commercial Travelers Repealed

Consul-General Church Howe, of Montreal, reports that the license or tax imposed some two years ago by the province of Quebec on non-resident commercial travelers representing persons, firms, or corporations having no place of business in Canada, was repealed by the provincial legislature on March 14.

There is now, therefore, no license required in this province by non-resident commercial travelers, except those selling intoxicating liquors, which latter will be regulated by the new liquor license, particulars of which will be sent later. It is also reported in the press that British Columbia has repealed the tax on commercial travelers (other than those representing liquor and cigar firms), thus "falling into line with the other provinces of the Dominion." Prince Edward Island, however, still imposes on non-resident commercial travelers a license fee of $20.

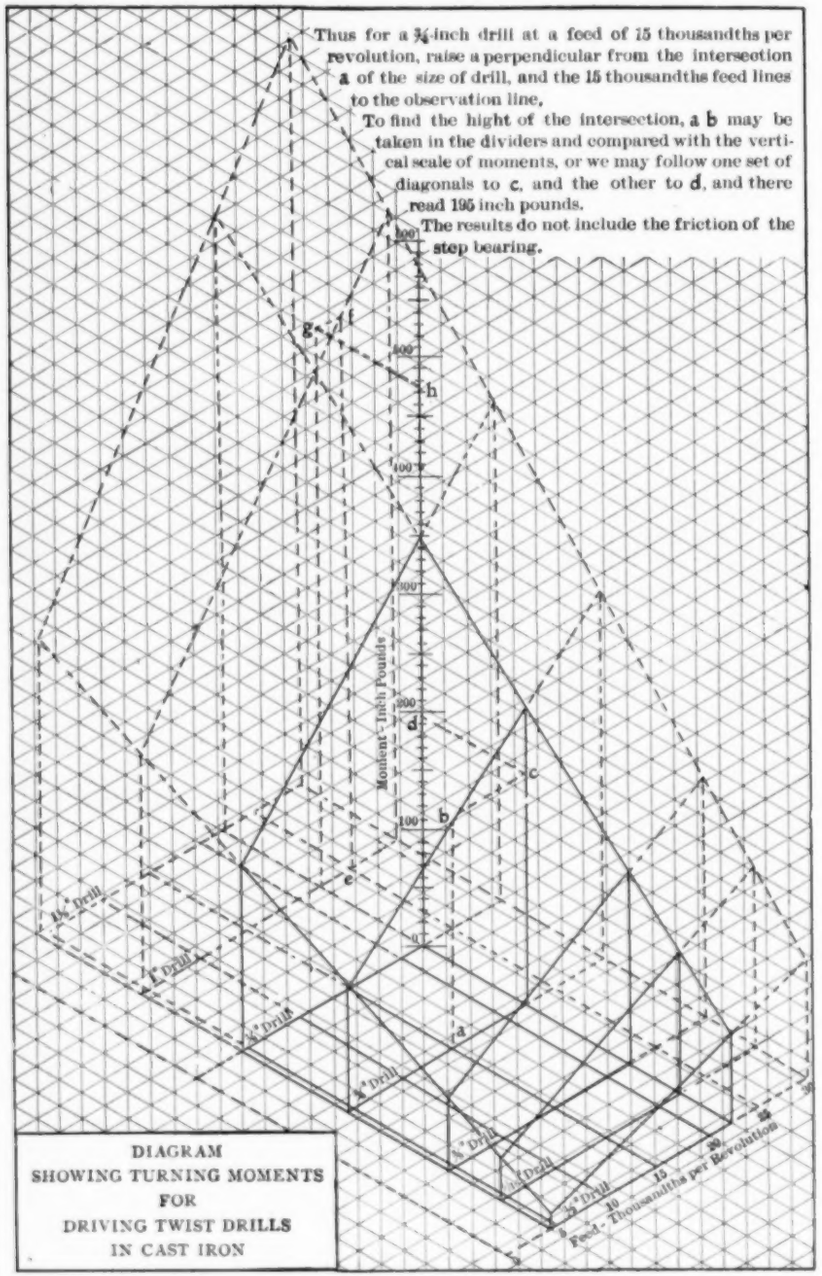

Thus for a ¾-inch drill at a feed of 15 thousandths per revolution, raise a perpendicular from the intersection a of the size of drill, and the 15 thousandths feed lines to the observation line,
To find the hight of the intersection, a b may be taken in the dividers and compared with the vertical scale of moments, or we may follow one set of diagonals to c, and the other to d, and there read 195 inch pounds.
The results do not include the friction of the step bearing.
Moment - Inch Pounds
Feed - Thousandths per Revolution
1½" Drill
1" Drill
¾" Drill
½" Drill
⅜" Drill
¼" Drill
⅛" Drill

DIAGRAM SHOWING TURNING MOMENTS FOR DRIVING TWIST DRILLS IN CAST IRON

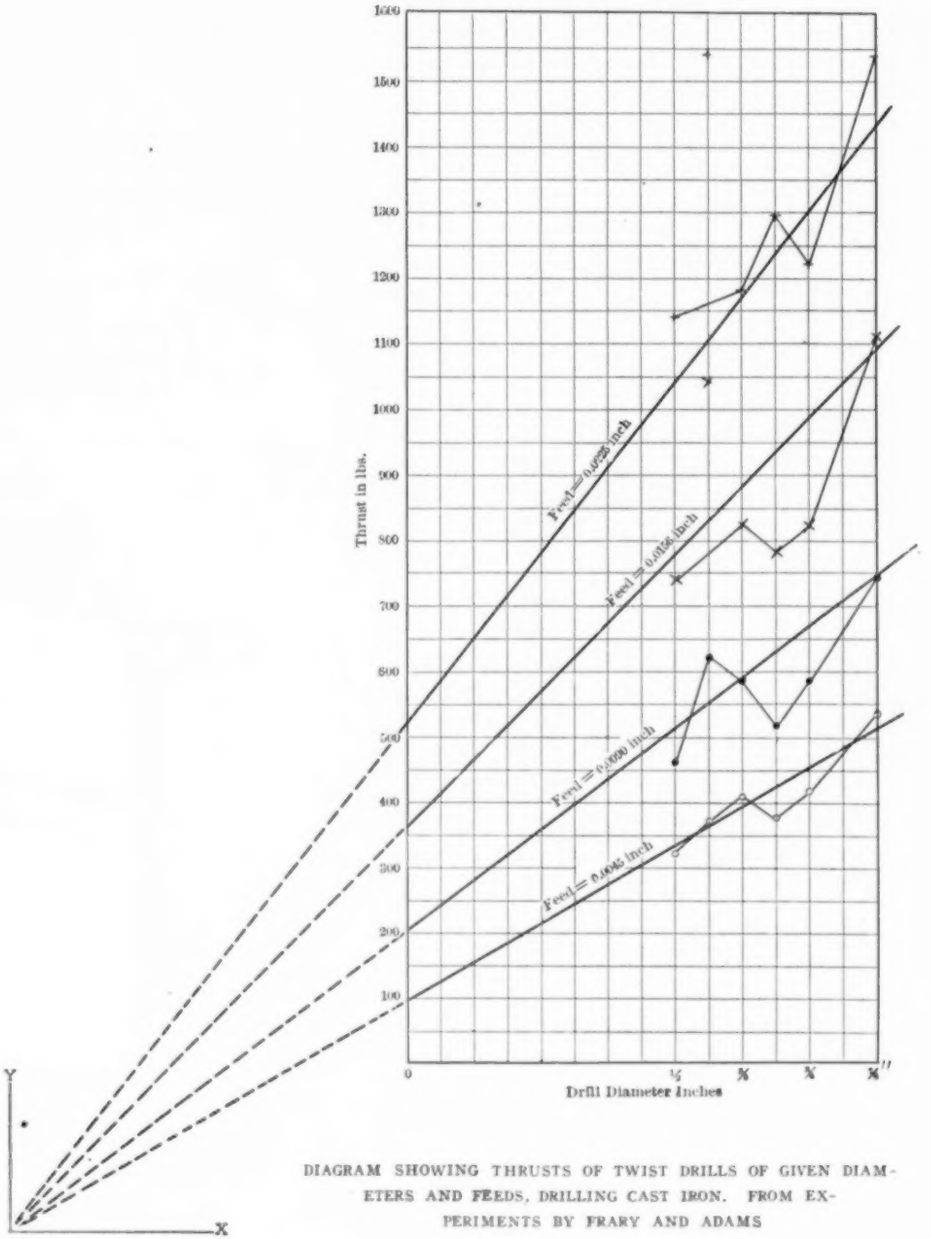


DIAGRAM SHOWING THRUSTS OF TWIST DRILLS OF GIVEN DIAMETERS AND FEEDS, DRILLING CAST IRON. FROM EXPERIMENTS BY FRARY AND ADAMS

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Horizontal and Vertical Drawing Boards

The increasing use of the vertical drawing board and its general popularity wherever it is tried have proved that as a competitor of the horizontal board it is here to stay.

There are two particularly urgent reasons why for pencil work the horizontal board should be discarded in favor of the vertical: one relates to health and the other to the matter of production.

Comparison from the Hygienic Standpoint

The matter of health is very often neglected, whereas it should be the draftsman's most important business to look after it, as upon it to a great extent depends his income. There is no question but that continual bending over the board, often resting the stomach on its edge, and the cramped position necessary are detrimental to health. I have known many draftsmen who were confirmed dyspeptics, and I do not doubt that in many cases it was brought on or at least aggravated by this position. Personally I can say that now even half a day's work over a flat board will cause me discomfort.

The Relative Output for the Two Styles

Looking at the matter from a productive standpoint, I have never met anyone who has worked over both styles of boards who does not consider the vertically inclined board much the faster. There is abundant reason for obtaining more speed on a vertical board. With the horizontal the body is in a cramped position, the weight of the upper part resting on the arms or elbows, leaving them free from the elbows out only; while with the vertical board one can either stand or sit, and have the free use of his arms. When in an erect position there is a better circulation, more blood goes to the brain, and there is not that tendency nor opportunity for dozing, particularly after lunch on a hot day.

Objections to Vertical Boards

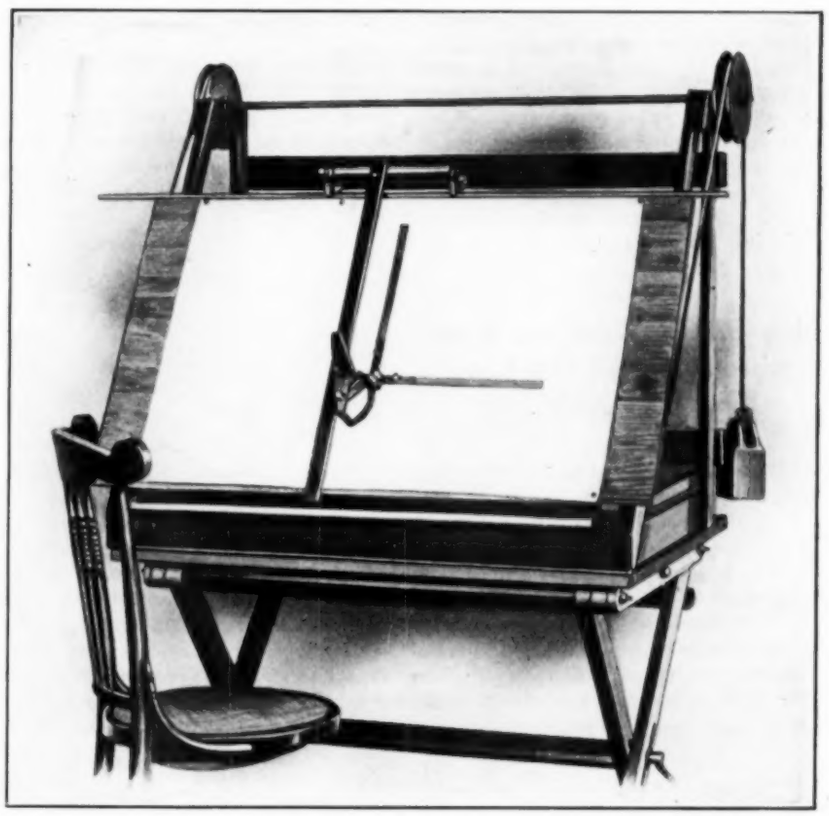
Of course when inking or tracing is to be done, a vertical board is not so satisfactory; but even for this work boards can be inclined much more with good results.

Of the objections to vertical boards I have never heard but two which were worthy of notice. One is that they are harder on the eyes. This I do not believe. The natural position in reading is to sit up straight, with a book nearly vertical before one's eyes, and there is no reason why at least as good and in most cases better light cannot be obtained in this way.

The other objection is that the vertical board involves the use of the parallel rule, which I will admit is not the most accurate of devices. But anyone who is careful can obtain good work from it.

A Substitute for the Parallel Rule

This objection was recognized at the works where I am employed, and we have substituted a device which is wholly satisfactory. We use, for all our pencil work, boards and tables of the design illustrated in the photograph, comprising a table of the usual form, readily adjustable for various angles, but generally set with the top approximately horizontal. On top of this table is fastened a substantial frame on the front of which the board is arranged to slide at an angle of about 60 degrees. The weight of the board is balanced by counterweights, supported by cords passing over wooden sheaves of large diameter, supported at the top of the frame. These weights are arranged so as to give the board sufficient movement so that that portion of the drawing on which one is working, whether it be at the top or bottom of the paper, may be brought to a suitable hight, whether the draftsman be standing or sitting. Then, if he is working at the top of his board, he does not have to stand on his tiptoes, on a step, nor hang his stomach on the edge of the board and stretch; nor, if he is working at the bottom of the board, does he have to develop a portion of a parabola with his neck; in either case he may have his work practically at the same hight, whatever is most suited to his dimensions.



A VERTICAL DRAWING BOARD WITH A SPECIAL DRAWING INSTRUMENT

The bottom of the board is provided with a ledge, which makes a convenient place for the instruments, and the flat table under the frame makes a handy place for keeping some of the drawings on which he is working. In addition the draftsman has at his side another table, nearly flat, for figuring and for inking in dimensions, etc.

The instrument which we are using was designed to meet the conditions of either

a vertical or horizontal board and to be free from the objections which are inherent in the parallel rule. It is illustrated in the photograph.

It comprises what is in short a vertical T-square, being a head provided with rollers of comparatively large diameter, and guided on a steel track; this head carries also in a small drum an adjustable spring balance, to which is connected by a cord a protractor which is adapted to slide upon the vertical blade of the T-square.

Pivoted to the protractor is a Y-shaped arm having a worm meshing with suitable teeth cut in the outer arc of the protractor. The teeth are spaced 1 degree apart, and the worm can be quickly thrown out of engagement with the protractor for quick setting to any even degree from 0 to 90; and by turning the worm when it is in engagement, adjustment of any fraction of a degree can be obtained. The Y-shaped arm is provided with scales which are readily removable.

With this instrument we are able to obtain great accuracy; by clamping the protractor to the blade, long straight and parallel lines may be drawn, and by actual comparative tests it saves about one-third the time in laying off pencil work. When it is desired to use more than one board, each board may be provided with a steel straight-edge, and the instrument readily transferred from one board to another. This instrument has recently been patented.

H. F. Noyes.

How Pattern Work was Economized by Making One Loose Piece do Double Duty

The accompanying photographic view and sketches show how one loose piece was used in two places on the same pattern. The half bearing shown in place at the left end of Fig. 1 was cast on both ends of the stand by ramming the mold up to the top of the bearing, drawing the latter out, putting it on the other end, and repeating the operation of ramming. The core made in the core box shown in the foreground in Fig. 1, and having a shape shown by the sketch, Fig. 2, was used to cover the openings left by the lower part of the journal bearing, doweled on pins which can be seen at the right-hand end of Fig. 1. After the loose-bearing part was drawn and the cores set in place, the mold was completed on top of the cores. This will probably be clearer by reference to

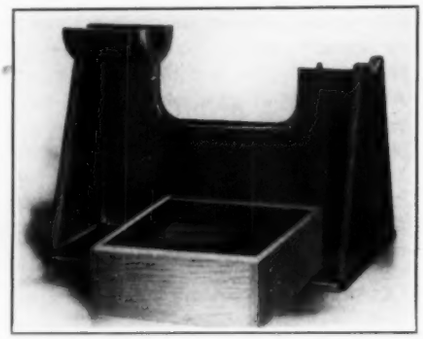


FIG. 1. PATTERN WITH ONE LOOSE PIECE FOR MOLDING TWO BEARINGS; AND CORE BOX

the sketches Figs. 3, 4 and 5. Fig. 3 is a vertical section of the mold with the loose journal-bearing piece in place on one end of the stand and the sand rammed up to the line *A*, or the top of the bearing; this being accomplished, the bearing

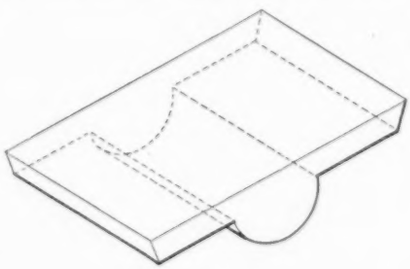


FIG. 2. CORE

piece is taken off and placed on the other end of the pattern, and the mold is rammed to the line *A* all the way across. The bearing is drawn a second time and cores are placed as shown in Fig. 4, which is an end view of the pattern in the mold. The mold is then completed to the top of the drag, over the cores. This leaves two spaces in the mold where the bearings were rammed up, and the body of the pattern is still in the mold. The drag is then rolled over and the cope is rammed in the usual way. After removing the cope, the main part of the pattern is drawn and the cope is replaced, which completes the mold.

How It Could Be Done in a Three-part Flask without Using Cores

By using the cores it was made in a two-part flask. If a three-part flask were used the operation would be similar, except that instead of using the cores the cope would be placed and rammed on the journal bearing that was in place on the pattern. Fig. 5 shows this method of molding. A flat drag is first rammed and the pattern is placed thereon. The cheek next goes on and is rammed to the parting line between it and the cope on the end where the loose bearing piece is placed. The cope is then put on and rammed over the loose bearing, then taken off and the bearing moved to the other end of the pattern, and the cheek is completed. The cope is then replaced and rammed over the bearing on that end. The cope is then removed and the loose bearing drawn a second time, the cope replaced and the mold turned over. The drag is lifted off, and the main part of the pattern drawn, the drag replaced and the mold is complete. It takes longer to tell about this than it does to do it. The core way makes a more satisfactory casting and also less work for the molder.

The Loose Piece Also Used As a Cap Pattern

The loose bearing piece was also used to make the caps for the bearings. This one bearing thus served to make virtually four castings, viz: the two journal bearings attached to the stand, which of course were really a part of one casting, and the two bearing caps. A principle is thereby demonstrated which can be applied in many similar cases.

J. L. Gard.

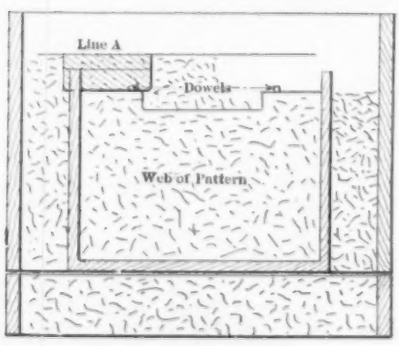


FIG. 3 Longitudinal Section of Two-part Mold, Loose Piece in First Position

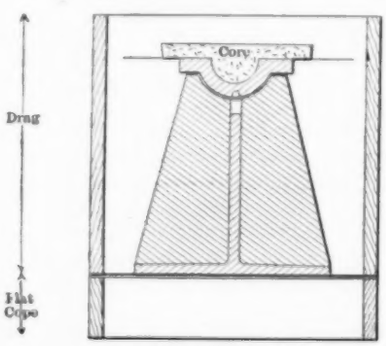


FIG. 4 Transverse Section of Two-part Mold, showing Core

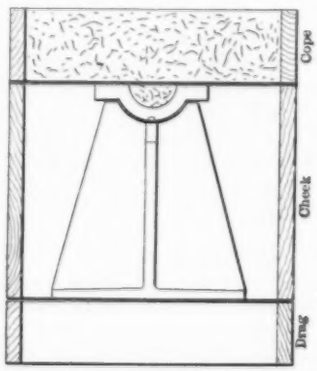
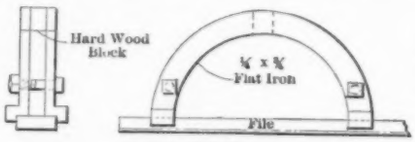


FIG. 5 Transverse Section of Three-part Mold

HOW PATTERN WORK WAS ECONOMIZED

A File Holder

Some time ago I made a file holder to use in filing down the valve seats of a small straight-line air compressor. It is of such a shape that one's whole weight can be brought to bear upon the file.



A FILE HOLDER

By changing the width of the block at the top different widths of files can be used.

BUTTE BOOMER.

Removing Burs from Screw-head Slots

At page 403, I noticed an inquiry as to the method used to remove the burs left by the slotting saw on slot-head screws. The method used in the screw-machine department where I am employed is as follows:

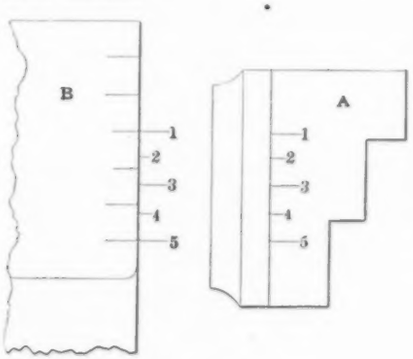
For every size screw there is a pair of tongs with the jaws tapped out to that size screw.

A man on day pay can grind the burs off from 8000 of these screws in 10½ hours and as high as 10,000 on piece work at 2 cents per 100. Of course this number can only be got out with a man who has had quite a little practice, our men having been with us a good many years. A new man would probably not do over 4000 per day.

PAUL W. ABBOTT.

A Graduated Chuck Jaw

Here is a kink for centering work in a chuck in a shorter time than it usually takes, or for adjusting the jaws any desired distance.



GRADUATED CHUCK JAW

It consists of the chuck jaw *A* with graduations 1 to 5, ⅜ inch apart. The lines on the chuck face are ½ inch apart, so that four spaces on the chuck jaw equal three on the chuck, as shown at *B*. The lines on the jaw should be on both sides and exactly opposite for best results, so they can be seen in any position of the chuck. This makes a vernier which will read in eighths of an inch, as can be readily seen.

SUBSCRIBER.

Keeping the Line Shaft Clean

I inclose a rough sketch of a shop kink I have seen used in the Western Electric Company's shops in Chicago for keeping its line shafting clean and free from rust.

Referring to my sketch, *A*, *B* and *C* are circular washers or disks, preferably of leather or heavy cardboard, with circular holes having diameters considerably larger than the diameter of the line shaft on which they are to be used. These washers can be split, as shown in Fig. 2, to facilitate slipping over shaft.

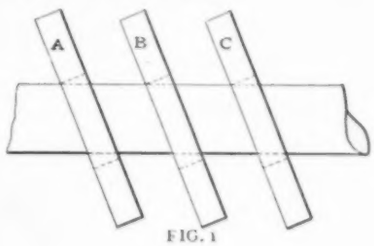


FIG. 1

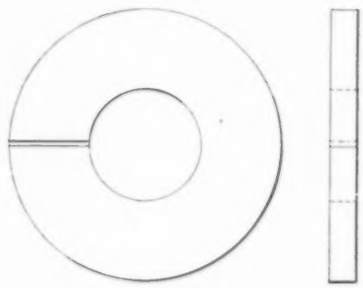


FIG. 2

KEEPING THE LINE SHAFT CLEAN

Any number can be placed between pulleys, but we use six or eight to every six feet of free line shaft. When the shaft revolves, these washers will travel back and forth on the shaft with great rapidity, taking the position in Fig. 1, always keeping the shaft bright and clean. The diameter of the washers with respect to the line shaft should be of about the same proportion as I have shown in the sketch.

Line shafts should always be kept clean, and these washers obviate the necessity of going over them once a month or so with emery cloth fastened to the end of a long pole.

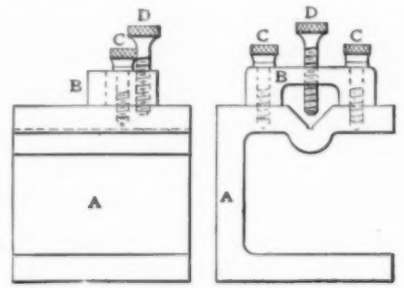
GILBERT MOUGEY.

A Combination V-Block and Angle Plate

We had been accustomed to "laying out" and testing our work with an ordinary angle plate and V-block. But this method proved so unsatisfactory that the need of a special fixture was rendered imperative.

Various suggestions were made by the men as to what would be a good design for a combination angle plate and V-block. The one shown in the drawing was finally accepted as being the most practical.

A is the body and is planed all over on the outside. *B* is a strap used for holding



COMBINATION V-BLOCK AND ANGLE PLATE

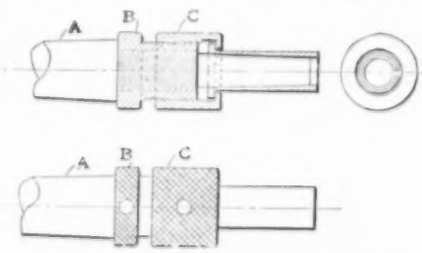
round pieces, arbors and the like, in the V. *B* is held by the screws *c c*, and has an elongated hole of 1 inch, which allows it to be adjusted to the edge. The nurled screw *D* holds the work in the slot. Any attempt at describing its merits, I think, would be superfluous. For any man who has laid out work with the aid of an angle plate will recognize the merits of this design without further description of how it should be used. With the three sides and ends planed, the fixture can be used in any position to accommodate the work.

PEDRO.

An Expanding Milling-machine Arbor

An expanding arbor which I have used to great advantage is shown in the cut. It was made for milling-machine work, the milling cutter being placed on the expanding bushing *D*.

The arbor *A* has a tapering end to fit the expanding bushing *D*, and the section near the shoulder is threaded for the nut *B*. *B* is threaded inside and partly outside, and the large outside diameter is nurled and provided with a hole for a wrench. The nut *C* fits over the nut *B*, with one end made to press against the



AN EXPANDING MILLING MACHINE ARBOR

shoulder of the expanding bushing *D*. This nut, also, is nurled and provided with a hole for a wrench.

In use the milling cutter is put on *D* and the nut *C* is screwed up tight. When the cutter is to be taken off the bushing

D, the nut *C* is loosened and the nut *B* is screwed up to the shoulder of the bushing *D* until the cutter is released.

This last operation is necessary, as the expanding bushing is drawn up so tightly on the tapering end of the arbor that if it were not provided with this nut *B* the bushing would be loosened with difficulty.

JOHN A. CARLSON.

Useful Appliances and Methods for Laying Out and Turning Pattern Work

I was very much interested in Robert Wyatt's ideas as illustrated at page 176. About eight years ago I had

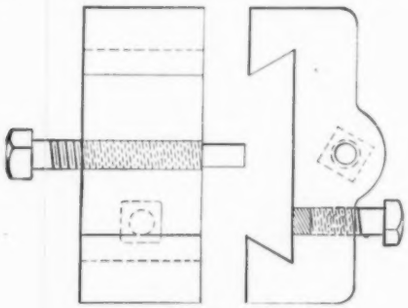


FIG. 1. AN ADJUSTABLE STOP

two similar tables made, only of smaller size, as shown at *H* in Fig. 4. I wonder how I got along before without them.

I also secured surface plate and angle plates as shown at *F, G, I.* These should be absolutely square. They can easily be blocked up at any desired angle by sawing out a block on the circular saw. By using the surface gage, quite accurate work can be done.

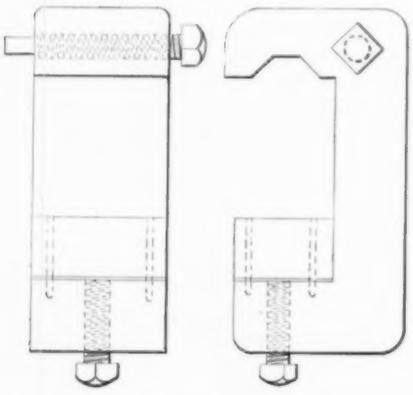


FIG. 2. ADJUSTABLE STOP

I was now pretty well supplied in that direction and turned my attention to the lathe. With very little expense it was made over as you will see in Fig. 3, *A A* being an index plate fastened to the pulley. *B* and section *B* show an eccentric adjustable bushing and index pin. Drill holes in the ring to index by, giving the divisions most useful for pattern work.

By planing off the V slots in the head and making a plate as at *C C* to fasten it to, the head can be swung to obtain an angle of 10 degrees, which is a very good standard for core prints. *D* is a taper pin to put in when head is in line with the ways. *E* is a screw to clamp it at any desired degree.

I hope that this will be adopted by some manufacturer, as it is a great time saver. Of course with a compound rest and an adjustable tailstock, more angles can be obtained.

J J is a wooden ring for an oil guard. *K* is pasteboard or thin wood to prevent to a certain extent dust getting on the belt. A lot of valuable time is lost by belts slipping in starting, as a high speed

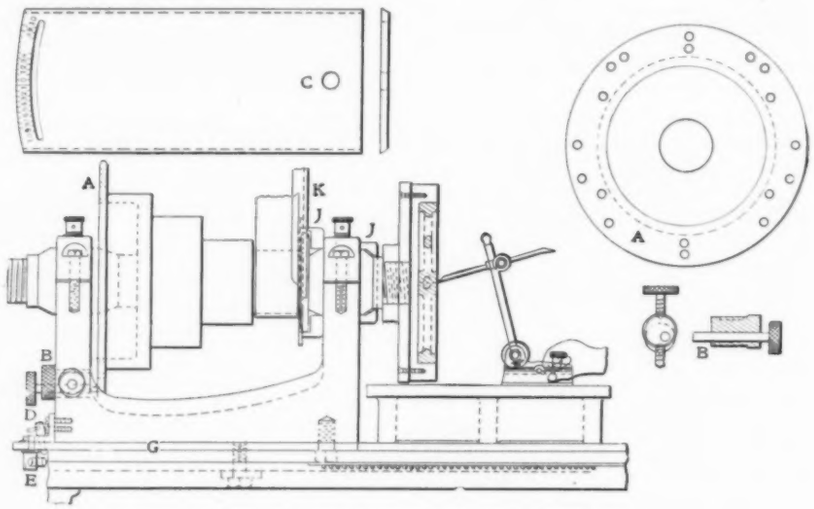


FIG. 3. THE LATHE AND ACCESSORIES

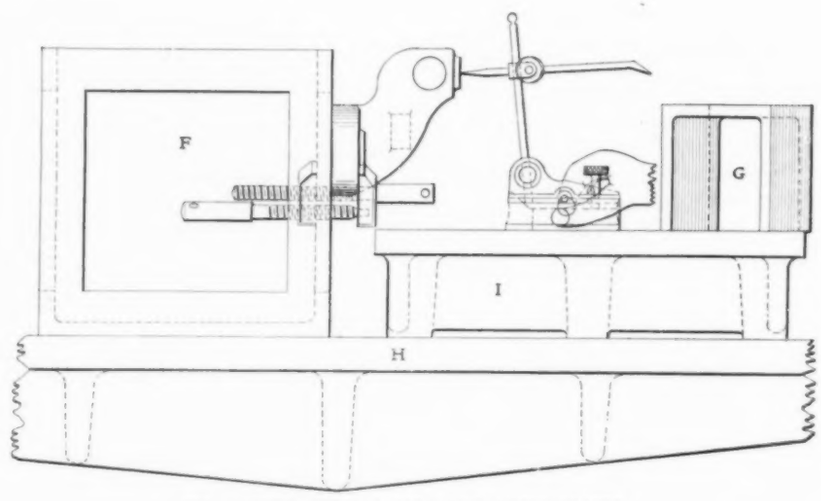


FIG. 4. THE SURFACE GAGE AND ANGLE PLATES

is mostly used. Adjustable stops, as shown in Figs. 1 and 2, are very handy, especially where duplicating of patterns is necessary. If closer work is required, use micrometers. Care should be taken to put no pressure on the screw, as wood compresses very easily from 0.001 to 0.003 under the micrometer point. Some of the readers of this article would say that

man ought to be sent to some sanitarium and treated for abnormal swelling, as castings are liable to vary from 0.01 to ⅛ of an inch. Yet it is necessary to have gated patterns correct measurement, especially metal patterns. It seems to be second nature, if castings come out, for the foundryman to say: "That pattern must be wrong. Let us look at the pattern." If no fault can be found with the pattern the trouble goes back to the right man.

N. A.

Why the Saw Teeth Broke

Once when I was engaged in some experimental work for an inventive individual it happened that we needed about a thousand small pieces which were practically segments of an 18-inch circle, and ⅝ inch thick. These were sawed from a ring by regular slitting saws, but one after the other of the saws broke until they were ordered by the dozen.

We laid it to the arbor running out of true, to the play in the bearings, to the vibration of the building, and tried to cor-

rect as many of these possible faults as we could, but to no purpose. They kept on breaking just the same. Flooding them with lubrication made no difference.

We changed speeds, feeds and everything else that was changeable, but they broke just as frequently as before.

Just at this time I thought of trying one more thing, so I took a saw to the tool-grinder, and holding it with my hands against the side of the wheel, ground nearly half of the tooth away on one side, and then the next tooth on the opposite side, grinding it all around that way.

We had found the cause.

The chips were now only about half the width of the saw, and as they could turn around in the saw cut they found an easy egress. Needless to say the job thereafter went much quicker, and no more saws were broken. EX-APPRENTICE.

Shading Circles

At page 255 is illustrated a tool for shading circles. I have seen a number of devices of something the same character depending upon changing the compass center, and it seems to be generally assumed that this is the only way to do this. I have wondered how many draftsmen are acquainted with the old method where the center is not changed but the fixed leg of the compass is sprung. This is simple and easy, has the advantage of not enlarging the center hole and I think it may be worth while to call attention to it.

The head of the compass is held between the thumb and forefinger and the middle finger is pressed against the fixed leg. It is surprising to one who has never tried it how much the pen can be moved out and after the pressure is removed the pen will come back exactly to the original position, this rendering it possible to shade evenly and quickly. The movable leg is, of course, not touched.

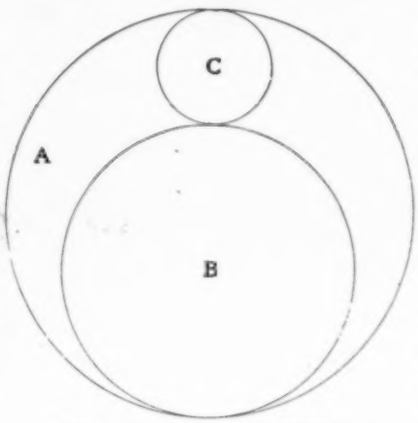
JOHN B. PEDDLE.

A Short-cut When Changing Pulleys

Assuming that anything in the way of a short-cut for machinists that will circumvent mathematics is liked by some and acceptable to you, the following may be of interest.

In changing pulleys on line shafts or other places it may be desirable to know how much to cut out of or add to a belt, and have it come right. That is to say, if a belt runs over two pulleys 30 inches in diameter, and the pulleys were to be changed to 36 inches, the belt would need to be as much longer as one pulley is larger around than the other.

The ordinary way to determine that would be to determine the distance around each pair and subtract one from the other; but that is not at all necessary, for the difference of the distances around two pulleys of unequal size is the same as the distance around a small pulley the diameter of which equals the difference between the diameters of the two. For instance: the distance around a 14-inch pulley is 44 inches, and the distance around a 21-inch pulley is 66 inches; the difference between the two is 22 inches; but, knowing the fact that the latter is the same as the distance around a 7-inch pulley, it is only necessary to determine that to get the correct result, 22 inches. The mathematicians will have to solve this algebraically probably, and some of the mechanics measure some pulleys before they will believe it, while, I hope, there are others who will take my word for it and go ahead. I do not know but this fact is as old as Egypt, and yet it may be new to many mathematicians, that the



THE CIRCUMFERENCE OF PULLEYS

circumference *A* in the illustration equals the sum of the circumferences of the two, *B* and *C*. JOHN E. SWEET.

Shop Accuracy in Making Gear Blanks

It is very evident to those having to replace old cast tooth gears with the more modern cast tooth gears, figured on the diametral-pitch basis, or with cut gears, that very little attention was given in the old days to the figuring of correct dimensions. As long as the "cogs" meshed sufficiently to revolve, they "fitted" each other and answered the purpose. I have come across gears of about three diametral pitch that had run together, with a difference between them of three-sixteenths of an inch in the circular pitch.

It would seem, however, in these days of mechanical advancement and accuracy, demanding among other features in a gear economy of power and noiseless running at high speed, that more attention should be paid to the correct sizing of the blanks. Unfortunately for both the gear cutter and themselves, many mechanics do not realize the importance of at least ordinary accuracy for this work. For replacement jobs the average mechanic seems to think that if he turns up his blanks "like the old ones," which are often worn almost beyond recognition, that the gear man will somehow or other cut them to fit. This is a mistake. If no one is at hand who understands the laying out of gears, he had better send the samples and order for a complete set to a gear-manufacturing firm whose experts can determine at once whether they are worthy of duplicating, or ought to be laid aside for a more modern design.

Passing now to the turning of blanks for new work, we will grant that the man in charge has been furnished with a set of working drawings for a lot of new gears. He gets out his patterns and forgets to add anything to the diameter for shrinkage. His castings will not finish out, so he tells his man to finish them "as large as they will go." They go to the gear cutter from 1/32 inch to 3/16 inch small on the diameter. Or perhaps he is getting out a lot of bevel-gear blanks. A mistake is made in setting the compound rest on the lathe and the face angle is out from one to three degrees. They are sent to be cut, with the note: "Gears are to run at high speed, and I want a first-class job." The gear cutter is expected to furnish correct gears, regardless of the incorrect blanks.

A firm gets an order for a number of machines requiring from 500 to 1000 bevel gears of two sizes, we will say 2-inch and 3-inch pitch diameter, 6 pitch, 12 and 18 teeth. These must be gotten out quickly. The machines are not high grade and the gear work, they think, is not very particular. The blanks are rushed out on an automatic screw machine or turret lathe and sent to the gear firm with the instruction: "Delivery of the greatest importance; only ordinary work required." But what a gear-cutting proposition, with blanks having holes varying from 0.005 inch to 0.020 inch, backing distance from 0.010 inch to 0.030 inch, and diameters and faces running out from 0.010 inch to 0.020 inch! Stock gear arbors are made only in standard sizes, and a machine once set for a backing distance should remain so for the entire lot. It is true that there is a way to overcome almost any mechanical difficulty, but the work is delayed and extra expense is incurred.

In the first case we have a lack of knowledge; in the second and third cases, carelessness; and in the fourth, a sacrifice of uniformity for speed, with the mistaken idea that it does not make any difference, and that the work is being rushed to advantage.

If mechanics would realize that in every case it pays to make their gear blanks with correct dimensions, or have their gears furnished complete by a firm making a specialty of the work, they would get their work quicker, at a better price, and with much more satisfaction.

C. E. CROFOOT.

A Novel Drive for a Grinding Machine

A Rope Drive Arranged in an Interesting Manner for Operating the Emery Wheel of a Grinding Machine with Long Bed

BY H. F. NOYES

This machine was designed at the works of the Landis Tool Company, Waynesboro, Penn., by A. B. Landis, and built experimentally to try out certain novel ideas in methods of driving grinding wheels. The object aimed at was to provide a drive which would be unaffected by the length of the machine and free from certain difficulties inherent in the design of long machines.

The grinder to which the drive was applied was one of the Landis standard machines, and outside of the drive contained no particularly novel features; therefore this description will be confined to the construction of the drive.

The method employed comprised the use of two endless rawhide ropes, one driven from each end of the machine, both running over the grinding-wheel pulley, the two being belted up so as to run together.

The general arrangement of the machine and drive, and some of the details of construction, are illustrated in the accompanying half-tones and line engravings. Figs. 1 and 2 show respectively front and rear views of the machine, and Fig. 3 is a general plan, showing clearly in connection with the rear view, Fig. 2, the arrangement of the idler guide pulleys behind the grinding-wheel base. Fig. 4 is a detail of the compensating arrangement in the drive, and Figs. 5 and 6 are sketches showing the arrangement of the two belts.

Referring first to Figs. 1, 5 and 6, it will be seen that each of the two ropes passes twice around the grinding-wheel pulley,

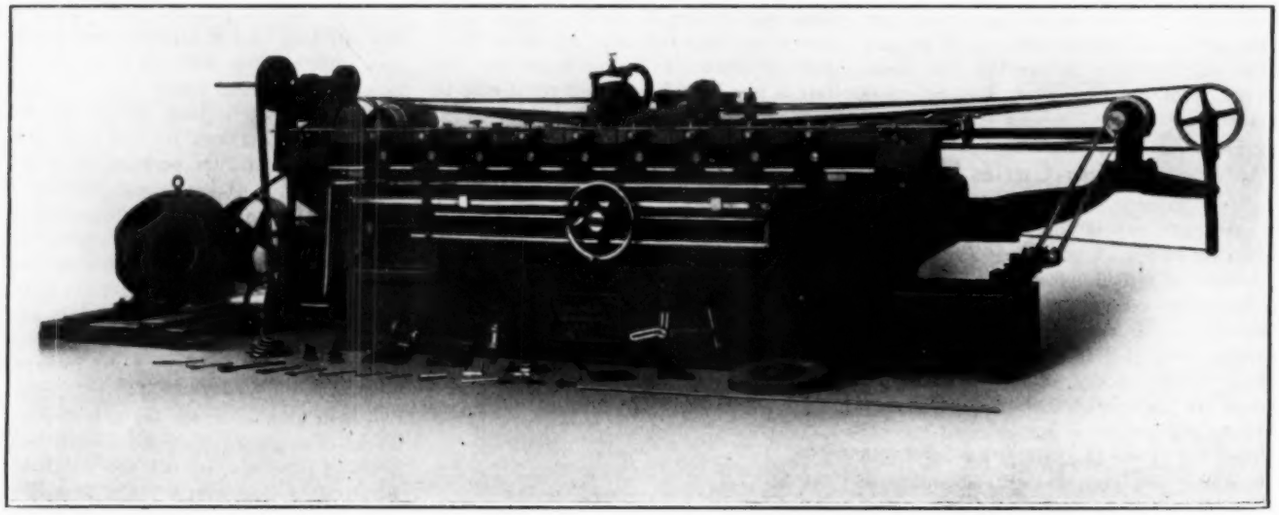


FIG. 1. FRONT VIEW OF GRINDER WITH ROPE DRIVE

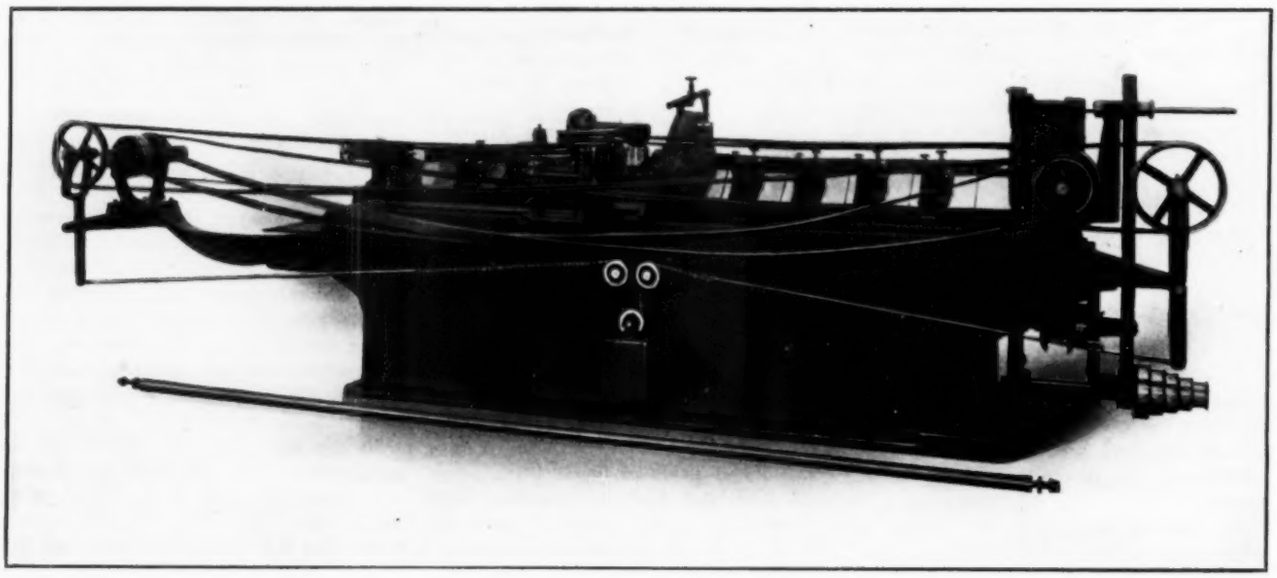


FIG. 2. REAR VIEW OF GRINDER

twice around its respective driving pulley at one end of the machine and its idler pulley at the other end, being guided to the grinding-wheel pulley by suitable idlers behind the latter.

The main drive for these ropes is situated at the left-hand end of the machine, where the compensating-gear shaft is located, and is driven from a motor. This compensating-gear arrangement, as illustrated in Fig. 4, comprises a narrow drum keyed to the shaft and has two bevel pinions engaging with two bevel gears located one on each side of the drum, both of which are loose on the shaft. To one of these gears is fastened a shell pulley having two grooves adapted to receive one of the ropes and drive it; to the other bevel gear is fastened a shell pulley arranged to receive a flat belt which drives a shaft at the other end of the machine. Fastened to this shaft is another grooved pulley, which is designed to receive and drive the other rope.

In order to understand the object of this compensating arangement it will be necessary to consider the longitudinal movement of the grinding-wheel base. When the carriage is in motion, the wheel base is bodily moved longitudinally of the machine. This movement would necessitate a slight difference in the relative speeds of the two ropes, or else there would be some slippage of one or both ropes on the grinding-wheel pulley, unless this compensating arrangement were provided. This can be more readily explained by considering the ropes at rest as far as driving the wheel spindle is concerned. Then, if the base be moved longitudinally in one direction and the rope *A*, Fig. 6, be held from any movement on its driving pulley, it will tend to rotate the wheel spindle in one direction, while under the same conditions the rope *B*, Fig. 5, tends to rotate the wheel spindle in the opposite direction. The variation necessary in the relative speeds of the two ropes is thus provided for by the compensating arrangement, which, while driving both the sheave pulley and flat pulley at approximately the same speed, allows one to run either slightly faster or slower than the other, as the case may require. To compensate for stretch in the ropes, and also allow for cross movement of the grinding-wheel base, each rope at the opposite end of the machine from which it is driven passes over an idler, which is

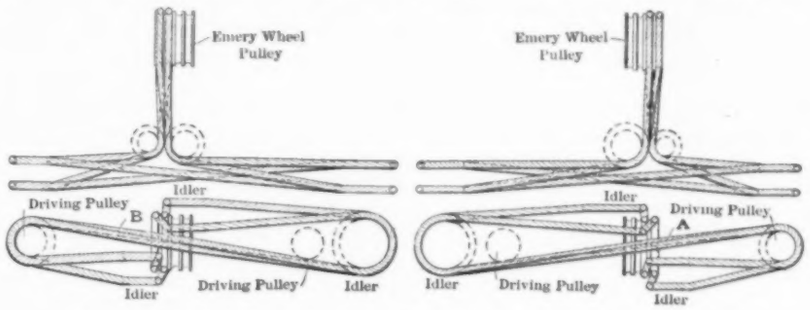


FIG. 5. SHOWING ARRANGEMENT OF THE TWO ROUND BELTS FIG. 6

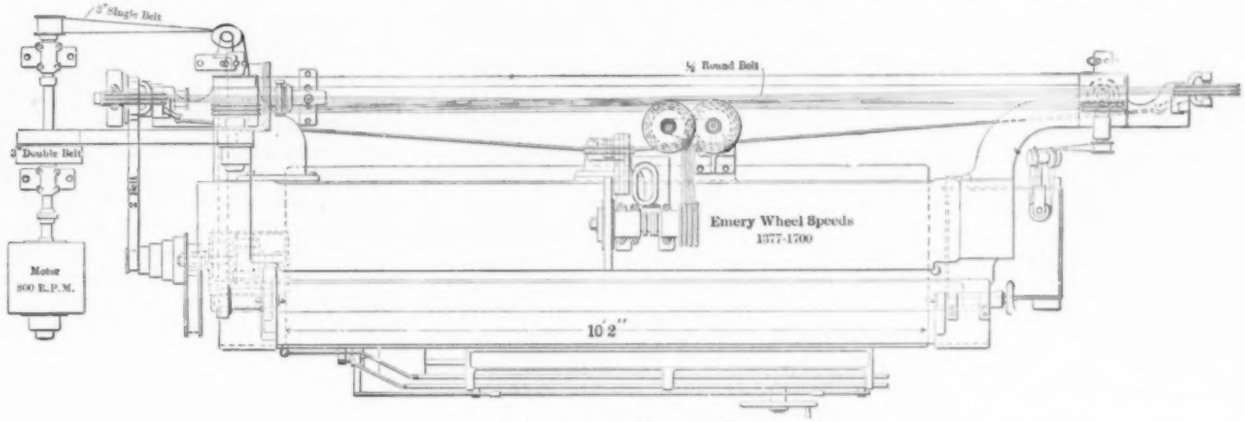


FIG. 3. PLAN OF GRINDER

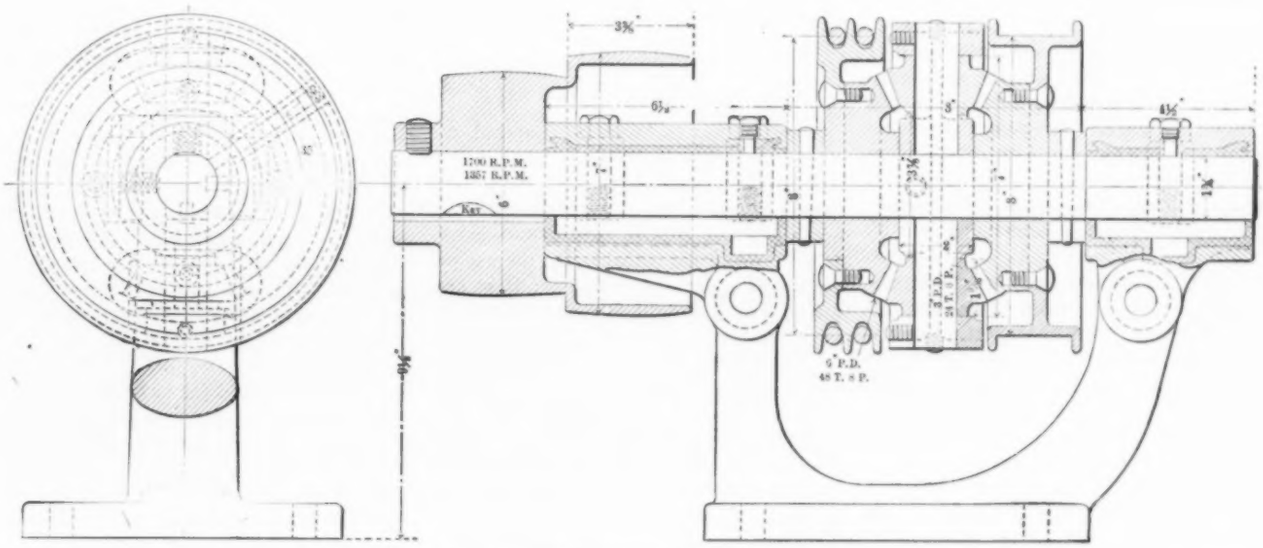


FIG. 4. COMPENSATING ARRANGEMENT

supported on a substantial arm, suitable tension being provided by means of a counterweight placed as shown in Fig. 2.

This drive has proved very powerful and, as will be seen, has the advantage that the bed of the machine can be lengthened indefinitely, requiring only a corresponding lengthening of the ropes.

Echoes from the Oil Country—Automobiles and Horse-power

By W. Osborne

The bicycle brought out a lot of talent and many new ideas, some of which stirred mechanical notions up for a time, but the activity that it created in these lines was feeble in comparison with what the automobile is doing. It is almost sure to be a treat, if you are not in a hurry, to listen to an expert automobile salesman. No matter how much of a mechanic you may be he is more than likely to tell you things concerning the advancement in mechanical science that are new to you.

If there is anything about an automobile that you can get more varied information about than the horse-power I do not know what it is.

Brake Horse-power

The highest mechanical skill is of course used in making the best of these machines. The world is searched for new and better material regardless of its cost, to the end that the result will be mechanical perfection. It may be that these things have something to do with the fact that the *brake* horse-power is an expression that does not seem to be very popular among those who set forth the glories of the automobile to the wondering public. The very word has a sort of disastrous sound to be avoided. After telling of the awful punishment their machine will stand without damage in going over the more than awful roads that are so easy to find and which used up the machine of the rival maker, they seem to avoid anything that might suggest the possibility of anything breaking, and so even steer clear of the brake horse-power.

I had an idea that the brake horse-power was a kind of fixed standard for measuring the actual power that an engine would deliver, but in passing around in an automobile show recently I became aware that I am behind the times and that there have been wonderful improvements made in the horse-power.

A Tip for the Purchaser

In ordering a machine it is evident that one should be careful to see that he gets the horse-power with it for if he happens to want it in a hurry and cannot find it and tries to borrow his neighbor's he may find that it will not fit his machine.

I am sorry that I cannot give very accurate details concerning any of these improved horse-powers. At an automobile show the representatives have to be careful because their rivals want to ferret out all of the improvements, so that unless you are one of their customers they do not care to give you inside information. To get all of this information it would be necessary to own one of each make of machine, and that could hardly be expected of a machinist. I did learn a few things about the matter, however.

Some of these newly invented horse-powers require only the bore of the cylinder; others have to have the stroke also before they can be attached. The speed box seems to be the place where some are used, while others are kept in the factory vault and are only applied when the engines are first built, or when sent in to be rebuilt. One firm, so I was informed, has one which it imported from France. It is the only one of the kind in this country and is guarded very carefully.

While it is difficult to get at the exact details of these improved horse-powers it is not hard to see the wonderful effects of their use. Here is a little engine that I should think would be about 3 horse-power with the old brake horse-power attached to it, but, presto, apply an improved one to it and there you have a 5 horse-power that you are confidentially told will even do much more. If it has been so fortunate as to have had the very highest improved horse-power attached to it it may even be an 8 horse-power.

"Infallible" Rules

Some of the publications devoted to motor boating, automobiling, gas-engine, and gas-power industries, etc., have had quite a lot in about these improvements. Some of these require only a knowledge of the bore of the cylinder and the use of a piece of paper and a lead pencil in order to be applied to any engine and in spite of all the efforts of the designer or of the builder that is the "true" horse-power of that engine.

Unlike the carbureters which will each and every one do that which no other one will do, these improved horse-powers are given away by the inventors, and it is in this fact that the danger to engine builders lies, and to builders of other machinery as well.

Just think of it! An unprincipled builder of gas engines sells an engine that, with his old-fashioned "brake" test, was 10 horse-power, and was so sold. It would not do the work that was desired. The owner applies his "rule" and finds that it is only 7 horse-power. Of course the maker is a swindler, for that "rule" is "infallible." It is "absolutely reliable and accurate," and was *invented* for the express purpose of preventing dishonest people from imposing on the public. The inventor himself acknowledges it, and if it were not so the editor of a reliable paper would not have published it.

Perhaps that same engine passes along and is for sale cheap. The man who buys it finds by another "more infallible" rule that it is now 14 horse-power. He tries to run a machine with it that the maker says can be run with 12 horse-power. Another rascally maker has been discovered, for there is something wrong when a 14-horse-power engine will not run his machine. The machine maker may claim that a 12-horse-power one will, but it is up to him to prove that he is right. Who ever heard of a "Solomon sitting in judgment" with one of these "rules" as his stock in trade thinking that it was up to him to prove that his rule was right.

One, at least, of these "rules" has been brought to such a state of perfection (?) that it will without alteration, and if one simply knows the cylinder bore, give the horse-power, no matter what the fuel, speed or design. The inventor of it states quite plainly that if any engine of the smaller sizes, say 12x12 and under, will not give the power this rule calls for, either the design or the workmanship is poor. If it is claimed that the engine will do more than the claim, it is a lie, so he says.

Individual Rules

If you wish to invent a rule of this kind for yourself, this is how to do it: Find the real brake horse-power of some engine under favorable working conditions. Square the diameter of the cylinder and divide the horse-power by the result. Your answer will be a constant factor for future use. Take any other engine of the same make, square the diameter of the cylinder, multiply by your constant factor and there is your brake horse-power of that size. After seeing how near you get with this make, try your rule on some other fellow's engines. As they are apt to be of a type that you are familiar with, the rule may apply to them as closely as it did to the first ones. From this conclude that it is good for any type.

Try it on an engine running on a different fuel and take the attendant's word for the horse-power, find that your rule agrees with his statement and conclude that it is right for any fuel. While you are at it, try it on a steam engine and find that it is just the thing. It does not fit all or any of these, but then it likely would if they were as perfect as the rule is. By hunting you will surely find some that it will fit. Here you have a nice little rule that is easy to remember and easy to apply, and while some people go to some refinement and get different factors for a four- and a two-cycle gas engine, and a still different one for a steam engine, yet this would seem to be unnecessary, as the

variations between the different types are not much greater than the variations in the same type as designed to meet varying conditions.

Since I began using a slide rule so that I am not so much afraid of a little figuring I do not use such rules much; but there is a little rule of my own that is also easy to remember, which I use in this connection. Whenever I find a man trying to make general application of such a rule, my rule is to think that he is either deceived himself or else he is willing to deceive others.

Heat Units

In the automobile show mentioned I heard a man say: "We have heat units, and we work them, too; they," waving his hand toward the exhibit of another concern, "don't have and can't get them. Everybody knows that you have got to have heat units on an engine to make it work right."

I had heard of heat units before, and had bothered my head some trying to understand how they work, but I had never seen one, so far as I knew. I wanted to stop and see about them, but the man who was talking had a nice bright diamond on his shirt front, and he was surrounded by gentlemen with silk lining in their overcoats and by ladies with fine feathers in their hats, and as they all seemed to understand all about it, I did not like to expose my ignorance. Besides that, I was in a hurry, and I know by experience that it takes quite a time to get a new idea into my head even when I am not in a hurry, and I am afraid that I did not look like a man who could buy an automobile with all of the latest improvements.

Taxameters in Berlin

With the exception of one firm the manufacturers of taxameters do not sell the machine outright in Germany, but rent them to the cab companies or to the individual cab drivers. The rental is 5 marks ($1.19) per month for horse cabs and 7½ marks ($1.78) for automobile cabs. For these rates the manufacturers deliver the taxameters to the cab owners and guarantee to the city authorities the perfect operation of the machines. The taxameters are given to the cab owners sealed, and neither the cab owner nor the driver is allowed to open the machine, such an action being punished by the authorities as a criminal offense. When the machines require repairs they must be returned to the manufacturers or their agents, who break the seals, make the repairs free of charge, and deliver the taxameters again sealed to the cab owner. To save time the taxameters requiring repairs are left with the manufacturer or agent, who immediately replaces them with machines in good condition. The renting system is considered in Berlin as the most satisfactory.—*Consular Reports.*

Experiences of a Traveling Mechanic

By Wanderer

From 1880 to 1887 the writer conducted a general machinery business in a village of western Pennsylvania, and in addition to making sales and installing the goods disposed of, attended to the repairs of a large number of steam boilers and engines of both stationary and portable types, steam pumps, etc.

Most of these were located within a radius of 10 miles from my headquarters and were generally in the country. They were used in flour mills, sawmills, salt works and small shops. The engines of portable type were used by farmers for threshing and hay-baling.

I also sold and installed large quantities of pipe for water and natural gas, so that while the life of the "master mechanic" was not "one glad, sweet song," it had its bright sides, and some amusing ones, too, as will be seen.

Engine Starters, not Engineers

Many of the engineers with whom I came in contact were good fellows, but unfortunately were wofully ignorant of the mechanism of their engines, or of the proper manner of caring for them. They could start and stop them, "grease" them and keep up steam, but these were the limits of nearly all. Their duties were of a rather mixed nature at most of the plants; in fact, often so numerous that, after starting up, the engine only received attention in spare moments snatched from more important (?) matters. Suggestions to the owners as to the many dangers attending this practice were generally met by a negative shake of the head and a smile of superiority, and occasionally with the reply that "they were running that part of the business."

One engineer at a salt works, who had been keeping his cylinder glands too tight and unequally drawn up, called on me to see a "pesterin' rod" which was giving him trouble.

Plugged Gage-cock Holes

An owner of a similar plant bought an ejector with which he purposed elevating water from a creek 10 feet below the ejector to a tank about 15 feet above it. I discovered that his boiler had but one water gage of any sort, and that was a Mississippi gage cock occupying the low-water opening. The holes for the two which should have been above it were plugged. There was no steam gage, and the safety valve apeared to be firmly cemented to its seat! He assured me that he was carrying 50 pounds of steam regularly, but the wheezy exhaust of the slow-moving old Faber engine did not indicate anything near it. After he had attached the ejector, it refused to lift water, although 20 pounds pressure was in excess of its requirement.

Thin Boiler Plate

On the following day his plant was idle and I went to it prepared to attach a steam gage. My helper began drilling a hole on the top of the boiler for a ⅜-inch pipe connection. After a few minutes' work he called me up and I found that the iron of the boiler was sinking under the pressure of the ratchet drill into a cup-shaped depression about 6 inches in diameter and half an inch in depth!

Calling the owner, I tried to impress the dangerous condition of his boiler upon him, but he only laughed and said that about ten years previously they had found that part of it getting thin, and, as it was at that time on the under side, they turned the boiler half-way round to bring the thin portion on top and thus make it safe!

Fifteen Pounds Instead of Fifty

After the gage was in place, we fired up and found the running pressure had been as I suspected, not quite 15 pounds. At 20 pounds the dangerous condition of the boiler was so evident that even its sanguine owner felt alarmed, but took no steps to remedy the matter, and the shadow of disaster which overhung him was only averted by his abandoning the plant as unremunerative about one year later.

Trials with Traction Engines

The traction and portable engines probably afforded the greatest variety of unexpected, and often annoying, occasions for repairs from careless and incompetent handling. Most of them had fusible plugs in the crown-sheets, but after the first melting out of one of these, the owner or engineer proved himself a man of "infinite resource and sagacity," as Kipling would express it, by replacing it with a plug of solid metal in order to prevent the "bother it caused!" One or two of these engineers realized the value of these soft plugs and decided to retain them, but being of an economical turn of mind did their own refilling of those which melted out. As they failed to entirely fill the opening, the hollow left on the upper part soon filled with scale and the "filling" then very promptly ran out.

Freezing up a Boiler

Another allowed his engine to stand without fire and with the boiler full of water, on an unprotected knoll in zero weather for two or three days. The only damage was a bad bulge on the outside sheet of the firebox on one side. As the steel showed no evidence of a crack, I had several of the staybolts renewed, and supplemented them with a few additional ones at the bulged part, but both owner

and those for whom he worked, always looked askance at the "lump," as they called it.

Dangerous Water Glasses

Several of these engines, although well built in every way by a firm of high reputation, had a very unsafe and unmechanical arrangement of the glass water gage. For some unexplained reason, these glasses were so attached to the sides of the boilers that even when the water began to show above the gland of the lower fitting it was still three inches below the top of the crown-sheet. The only reason I could imagine for this plan of attaching the glass was to enable the lower fitting to be screwed into the sheet at right angles, as a higher point brought it on the curve of the sheet.

I remedied this trouble by plugging the lower opening and fitting a piece to the shell higher up in such a way as to enable a hole to be tapped at right angles to the perpendicular and then used 8-inch glass tubes instead of those 12 inches in length. After this change, repairs to fireboxes were not so often required.

Taking Account of Prejudice

The owner of another of these traction engines desired a steam brake and I prepared one using a cylinder 3¼ inches in diameter with a maximum stroke of 12 inches. An ordinary three-way cock connected it to the boiler, while the piston was coupled to the brake lever already on the machine. The cylinder was held in place by two bands of iron each ¼x2 inches which encircled the boiler, and both the owner and I felt rather proud of our arrangement. Trouble, however, arose from an unexpected source, as the "honest farmers" for whom he threshed imagined these bands were applied to meet a growing weakness in the boiler, and feared an explosion! So we were obliged to remove them and substitute studbolts.

Cementing a Crown Sheet

Investigating an explosion of a traction-engine boiler in my territory, I discovered that its crown sheet had been burned at the front end and the owner had taken it to a shop where salt-evaporating pans were used. The "machinist" repaired the burned crown sheet with what he called a "cement patch," a form of repairing followed with the salt pans. Then the engine was taken to a job of threshing and all things were moving along merrily, when suddenly the crown blew down and the engine turned turtle into the barn, scattering fire and hot water in every direction, killing a man and burning the barn and contents.

A Farmer Who "Knew"

A large traction engine owned by a farmer who boasted of having acquired a thorough knowledge of engines and boilers in the oil regions began leaking, and repeated visits of a boilermaker whose services I obtained from the locomotive works of H. K. Porter & Co. only temporarily remedied the trouble. As I had neither seen the engine nor the boilermaker, the engine being several miles out in the country, and the boilermaker, whom I knew to be perfectly reliable, having gone to and from the work directly from his home shop, the continued trouble led me to interview this man, and he informed me that the boiler was so badly burned that permanent caulking was impossible. My next move was to visit the engine. This confirmed the man's statement.

The crown sheet and side sheets were buckled out of all semblance to a plane surface, and as the owner was absent, I informed his wife that if she desired her family to continue unbroken she should insist that her husband allow me to have a new firebox put in before the boiler would ever again be subject to steam pressure.

Woman's Influence

Meeting this man on my way home, I made a full report of the conditions and the necessity of prompt repairs, but he only laughed heartily and referred to his oil-region experience. However, he came to my office early the next morning and directed me to have the new firebox put in as soon as possible, adding that he was not afraid of the old one, but his women were!

Very few who owned or ran these traction engines ever cleaned them, and as I not only was obliged to expend considerable time removing dirt in order to reach parts requiring repairs, but also had men injured on account of wrenches slipping through the dirt preventing a secure hold, I gave them their choice of keeping the machines clean or paying for the time my men would consume in cleaning at machinists' wages when called on to make repairs.

A Tipple That Wouldn't "Tip"

Ludicrous blunders were not always made by the class referred to, but sometimes occurred among those whose qualifications entitled them to a reputation for freedom from such inaccuracies. During the eleven years preceding the experiences just narrated I had charge of a mechanical department of a large coal company in the same region. To us there came a young man with a brand new diploma from an Eastern technical college. One of his first projects was an elevator to raise slack (coal screenings) from the tipple to a point convenient for handling.

As a motive power he designed a huge overshot water-wheel 20 feet in diameter and 30 inches across its buckets. It was meant to drive a belt elevator with buckets of a capacity of half a bushel. The drainage of the mine was to be utilized as the wheel's source of power. Although a first-class millwright who was directed to make this wheel, tried to convince its designer that under the existing conditions it would be impossible to obtain the power desired, this well meaning and thoroughly practical man was instantly overwhelmed with a flood of theoretical platitudes on heads, cubic feet, units of resistance, and what not.

Not Enough Power

The result was a completed outfit of fine workmanship exactly corresponding to the ideas of its designer. After its completion, a number of interested observers saw the wheel start off merrily and the elevator buckets chasing on their endless race. Then the slack was turned in and as the buckets filled the speed decreased until the thing came to a dead stop! Further experiments demonstrated beyond question that the largest buckets which could be used must not be of a capacity exceeding one quart each!

Needless to say the machine was never used, but stood silently accumulating coal dust and rust for several years until the building of a new tipple necessitated its removal.

Why the Injector Didn't Work

Another expert wondered why the Sellers injectors he had attached to a pair of boilers refused to work. After considerable experimenting, a man was sent from the factory to investigate matters, and he soon discovered that the flanges in which the checks had been screwed were attached without the preliminary of cutting holes through the boiler sheets!

This article would be incomplete without a personal reminiscence which modesty (?) reserved to its close.

Saving (?) Lumber in Car Repairs

Soon after entering on the duties of the position referred to, the writer began to think that sufficient economy was not exercised in repairing the company's cars. Soon illness of the foreman of the wood shop elevated me temporarily to his position, and it was not long until an opportunity to "save" presented itself. A gondola came in from a wreck in which another car had been thrown across it, breaking half of one side plank into splinters, but leaving the other half intact.

Now these planks were of 3-inch pine, 24 inches wide and 30 feet long, and the "new" foreman seeing a fine opportunity for economy, decided to splice the broken portion, and did so by cutting the piece required for the purpose from an entirely new plank of full length!

When the regular foreman returned he was seen to examine this piece of work carefully, and then with a deprecatory shake of the head, turn to the economizer and say: "What will you do with the other half of that new plank?"

Boring Cylinders of Automobile Engines

By Anglo

I was very much interested in the article under the above heading at page 286. While it is a fact that boring mills are giving way to large turret lathes for this operation in some instances, yet the horizontal boring mill can hold its own with any turret lathe on certain designs of cylinders.

The most common automobile cylinders in Europe are those cast in pairs, i.e., two cylinders in a single casting. This is where the boring mill scores heavily, as we bore both cylinders at the same time. The castings are first milled on the bottom of the cylinders, and the top of the combustion chamber, on large slab millers; they are then taken to the boring mills, and bolted square up against an angular bracket, and another gray-iron bracket is bolted on the front end of the boring-machine table, about 4 inches in front of the bottom end of the cylinders. This bracket has two holes bored in it whose centers are exactly the same as the centers of the cylinders required to be bored. The boring bar proper passes through the hole near the front of the bracket and carries a steel pinion with sliding feather, a short stiff boring bar with a ball-thrust collar being fitted into the rear hole; this bar also carries a pinion the same size as the one on the main boring bar, and a stud between the two boring bars carries an intermediate pinion which meshes with the two other pinions. Thus the boring bar drives the other cutter bar, and both revolve in the same direction. We have been boring cylinders in this way during the last 18 months, and find it by far the quickest way yet devised. A youth can bore in one hour two cylinders of 4-inch bore by 4½-inch stroke; the cutter bars operating in the two cylinders at the same time. The device is very simple, and practically doubles the output of any boring mill of the horizontal type.

We take two cuts in each cylinder, using first a flat roughing cutter, and then a boring head carrying three cutting tools. The boring head has a slot milled across the back face ⅜ inch deep, and is driven by a flat steel cotter in the cutter hole through the bar. Thus no time is lost in changing cutters.

The same cylinders we formerly handled on some large turret lathes of the latest type, carrying a special fixture on the face plate, with a slide across the center and locating pins for accurately setting the cylinders for boring to their correct centers. The quality of work turned out was all right, but, of course, we could bore only one cylinder at once, and consequently they cost us more than double what they are costing us now, as we had to have a higher rated man on the work. One thing is certain, we shall never go back to the former method. My contention is that turret lathes score over horizontal boring mills only when the cylinders are cast separately, which is not often the case now.

The method which I. B. Rich advocates, that is, rough boring first, and then taking the cylinders out of the lathe, and letting them stay until they have had sufficient time to relieve their internal strains, before they are finished, we find altogether unnecessary; and as this would necessitate two settings instead of one, with these very irregular shaped and ill-balanced castings, this method would add very considerably to the cost.

To get good compression and a highly-finished surface in these cylinders it is an admitted fact now that the only method giving accuracy is to finish them on the grinding machine. Thus, while we finish the cylinders at one setting only, after the strains are neutralized we finish by grinding.

L——, England.

A Brazing Flux for Cast Iron

By Ethan Viall

It is always annoying to have parts break, whether they are big or little, but I know of nothing more exasperating than to break some small cast-iron piece, the importance of which is away out of proportion to its intrinsic value.

How often has a man spent hours fussing and fuming, trying to patch up a broken casting, when some way to mend it similar to soldering, but stronger, would have saved much time and trouble. Indeed, in some cases, soldering has been resorted to where strength was not required, but as a usual thing a stronger joint was needed and so attempts were made year after year to find a flux that would enable us to braze cast iron. Many a man has had his heart come up into his mouth upon finding, that after repeated attempts, he had actually brazed a piece and the brass had flowed beautifully, but alas, just as he was about to shout "Eureka!" he discovered that the casting was malleable and not cast iron.

The brazing of cast iron had been attempted, without success so often, that it was looked upon by most mechanics as being in the same class with soldering aluminum or hardening copper. And it was not until five or six years ago that it was successfully done. A German was, I believe, one of the first to do this, and he obtained a patent on his method, which consisted mainly in coating the joint with a mixture which was principally oxide of copper and borax boiled together, and then brazing with a flux containing carbonate of soda, boric acid and salt. To use this, one had to purchase the mixture of certain parties and also have a shop license. The cost was not only prohibitive, but the method insisted upon was clumsy and troublesome.

I was one of the first to use this method, under a license, and quite by accident discovered another flux, far better, and entirely different, which could be used exactly as one would use borax in ordinary brazing.

I had for years at odd times tried different chemicals alone and in combination, but without success, when a chance remark dropped by a friend of mine, an expert chemist, regarding the properties of common chlorate of potash, furnished me with the hint I needed. After several weeks of experimenting, I evolved the following formula, which is not patented and can be used by anyone who cares to try it, and which I have used for over four years and which has been used by several of my friends. If a similar formula has ever been given I have never heard of it and this one is entirely my own. The proportions were obtained by careful experiment.

The ingredients may be obtained at any drug store.

The formula is: Boric acid, 1 lb.; pulverized chlorate of potash, 4 oz.; carbonate of iron, 3 oz.

They should be mixed together dry and will look like powdered brick dust. The amount specified should cost about fifty cents and when used should be mixed with grain spelter.

After arranging my pieces to be brazed, I heat them to a nice brazing heat and apply my flux and spelter with an iron rod, flattened on the end to a rough spoon shape, just as if I were brazing a bicycle frame in the usual way.

The chlorate of potash, must be pulverized, but the iron may be what is known as either carbonate or subcarbonate. The mixture should be kept dry as moisture or long exposure to the air renders it less efficient.

In arranging the pieces for brazing, I either lightly clamp them together or use stiff fire clay to hold them in place, but anyone who has done ordinary brazing will readily find a way to fix the pieces. The size of the pieces which can be handled successfully is limited by the heating facilities.

A gas or gasolene forge is best, my preference being for the gas. A coal forge may be used, however, though it is not so convenient and when it is used, coke or charcoal should be burned as coal does not make a clean fire. When properly brazed a casting cannot be broken again in the same place. I give this formula to my brother machinists and readers of the American Machinist in the hope that it may be of as much practical use to them as it has been to me.

(*Continued from page 596*)

The Dedicatory Exercises

The dedicatory exercises were held in the main auditorium on the afternoon of Tuesday, April 16, and were in every way fit and appropriate. The program was as follows:

1. Music. Largo, Handel. The Richard Arnold Double Sextette.
2. Opening by Charles Wallace Hunt, past president A. S. M. E., presiding officer. The first use as a gavel of the setting maul employed by Mrs. Carnegie in laying the corner stone of the building.
3. Prayer by Rev. Edward Everett Hale, D.D., Chaplain U. S. Senate.
4. Communications from the President of the United States; the President of the Republic of Mexico; the Governor General of Canada.
5. Historical address by Charles F. Scott, chairman of the building committee.
6. Acceptance of the building by E. E. Olcott, president of the United Engineering Society, representing the Founder Societies.
7. Address by Andrew Carnegie, donor of the building.
8. Music. Träumerei, Schumann. Cello solo, Kronold.
9. Oration by Arthur T. Hadley, president of Yale University, "The Professional Ideals of the Twentieth Century."
10. Music. Hallelujah Chorus. Handel.

Mr. Olcott's address was brief and pointed, and was preceded by the placing over his neck of a red, white and blue ribbon, to which was attached the key of the building. The key has a gold head, made by Tiffany & Co., with symbolic inscriptions. Upon one side is a small crystal of quartz, behind which are some tiny particles of gold which are the very first to have been washed from the gravel of California in 1848—the gold being a contribution from Tiffany & Co.

The most striking point brought out in the address of Mr. Scott, was the statement that in every essential thing the action of the building commitee was unanimous—every resolution having been passed by a unanimous vote.

Mr. Carnegie was, of course, received with tumultous applause. He spoke in his happiest vein, and in part as follows:

"Mr. President, Mr. ex-President, Mr. Present President, and Uncle John Fritz," he said, and then he had to stop again for the applause to subside.

"The Scotch have a saying," continued Mr. Carnegie, "and they have many wise sayings, that fools and bairns should never see a thing half done. I do not want to associate myself with fools and bairns, but I think I may add that donors should never see a thing half done.

"It is the spirit of the men that does the work; the safety of human society lies just here. Whenever we coalesce to do some good, a unification takes place and a consolidation; and whenever men meet to conspire against the public good—to do some evil—they find themselves unable to trust each other. That's why you needn't lie awake nights and worry about the future and about what problems society is going to meet. As sure as the sunflower turns toward the sun so the human race turns toward better things."

"Who are the architects?" he said. "Are they a well known firm? No. They are two young men who perhaps were never heard from before in New York, and there is the proud father of one of them (pointing to Dr. Hale), and there is a proud lady sitting up there in the gallery (pointing to Mrs. Carnegie), for the other one was Mrs. Carnegie's brother. There's democracy for you. No social influence in determining the architecture of this building, but twenty-eight sets of plans out of which this one was selected by unanimous choice."

Mr. Carnegie had a word to say for universal peace, to which he arrived by speaking of the American spirit of cooperation. This, he declared, was not found in the Englishman, nor yet in the Scotchman.

"Where are you going, Sandy?" said one Scotchman to another in the story that Mr. Carnegie told.

"Doon to the club," said Sandy.

"An' wha foor?"

"Just to contradeect a wee bit."

"We only hate those we don't know," said the donor of the engineering building in conclusion, "and the more I go on and the younger I get, and the more experience I have with men and women, the more I come to realize the truth of this. To know the virtues of your brother is to know the spirit of brotherhood. That is why I am an advocate of the peace of the world. We only have to go on to know our brothers the world over in order to realize that all men of all nations are indeed brothers."

President Hadley's Address

President Hadley's oration was a striking tribute to the work of the engineer, and a still more striking outline of the larger public duties in shaping public opinion which engineers are apt to neglect. He spoke in part as follows:

The men who did more than anything else to make the nineteenth century different from the other centuries that went before it were its engineers. Down to the close of the eighteenth century the thinking of the country was dominated by its theologians, its jurists, and its physicians. These were by tradition the learned professions, the callings in which profound thought was needed, the occupations where successful men were venerated for their brains. It was reserved for the nineteenth century to recognize the dominance of abstract thought in a new field—the field of constructive effort—and to revere the trained scientific expert for what he had done in these lines. Engineering, which a hundred years ago was but a subordinate branch of the military art, has become in the years which have since elapsed a dominant factor in the intelligent practice of every art where power is to be applied with economy and intelligence.

What the Building Symbolizes

A building like this is therefore the symbol of all that is most distinctive in the thought of the century that has gone by. A hundred years ago we might have had a building in honor of theologians, or of lawyers, or of physicians; but one that symbolized the achievements of the engineer was beyond men's dreams, because the world at large had neither felt the need of his work nor dreamed how soon it should be seeking his leadership.

President Hadley dwelt on the fact that it is the engineer who makes physical science in its various lines applicable to the complex problems of constructive development. "Yours," he said, "is the proud boast of having in one brief century established science as the arbiter of the material affairs of mankind, and of having enforced her worship upon a world once reluctant but now gloriously admiring." He continued:

What, then? you will ask. Is there anything that remains to be done comparable in importance to this? Yes, there is. An equally large part—perhaps in one sense a much larger part—of your professional duty yet remains to be accomplished. It is not enough to know the special sciences on which the practice of a profession is based. A man ought to have clear conceptions of the public service which his profession can render, and the public duty which its members owe. Thus, and thus only, can the engineer, the lawyer, the physician, or a member of any of the learned professions rise to the full dignity of his calling.

Two Standards Required

For there are but two distinct qualities which must be combined in order to secure the best professional service; two quite distinct tests which work must meet in order to be pronounced first-class. One of these is the technical standard; the other, for want of a better word, may be called the ethical standard.

The man who wishes to build a good railroad must not only lay it out according to the rules of the surveyor's art, with the proper curves and grades and bridges which will not fall, but he must also have some intelligent regard to the needs of

the population, the safety of travel, and the many other factors which determine whether a railroad shall be a work of public use or a source of industrial bickering and financial disaster. . . .

This larger view of professional obligations is not so fully recognized as it should be. We have in the nineteenth century made so much progress in the technical training of doctors and lawyers and engineers that we sometimes forget that there is need of anything more than technical training. We have let the old idea of public leadership, which was prominent in the minds of the great professional men of past centuries, give place to another and narrower ideal which is fully satisfied when a man has made himself a technical expert.

Many a man of real eminence in his calling deliberately rejects the wider conception of professional duty which I have here indicated. Perhaps he recognizes the claims of public service, perhaps he does not, but in any event he believes that these claims rest upon him as a man rather than as an engineer or a lawyer.

In his professional capacity he says he is hired not to tell what the law ought to be, but what it is; not to advise how a railroad can do the most public service, but how certain men with certain ideas of their own can best use the differential calculus to get those ideas carried out. This is perhaps the prevalent view of professional ethics today. I believe that it is a wrong view, which must menace not only the influence and standing of the professions themselves, but the general interest of the republic.

The Reception

In the evening the members and their friends were received by the officers of the three societies in the main auditorium, and in the offices of the individual societies. The reception was attended by a large number, the entire building being thrown open for inspection.

The Wednesday Afternoon Exercises

The program for Wednesday afternoon was as follows:

1. Introduction by John W. Lieb, Jr., chairman of Dedication Committee.
2. Addresses by presidents of Founder societies: Samuel Sheldon, President, A. I. E. E.; F. R. Hutton, President, A. S. M. E.; John Hays Hammond, President, A. I. M. E.; T. C. Martin, President, The Engineers' Club.
3. Greetings and Felicitations from Foreign and National Scientific Societies and Institutions of Learning.
4. Address by James Douglas, Past President A. I. M. E.
5. Presentation of the John Fritz Gold Medal to Alex. Graham Bell, Past President, A. I. E. E.; (By Charles F. Scott, Chairman John Fritz Medal Board of Award.)
6. Presentation of Commemorative Medals for Distinguished Services to: R. W. Pope, Secretary, A. I. E. E.; F. R. Hutton, Past Secretary, A. S. M. E.; Rossiter W. Raymond, Secretary, A. I. M. E. (By A. R. Ledoux, Past President, A. I. M. E., representing the three societies.)

The hit of the afternoon was the address by T. C. Martin, who recited some verses which related to the proximity of the new Engineers Club building, which stands back to back with the societies building, and is connected therewith by a flying bridge. Each verse concluded with a reference to "the little club near-by," which, in its many repetitions, brought down the house.

In addition to the exercises described, each founder society held a professional session during the week, and on Friday evening there was an informal smoker and vaudeville entertainment at the Madison Square Garden concert hall.

Methods of Machining Steam-turbine Cylinders and Wheels

By E. Russell

The steam turbine has fairly started to crush its reciprocating brother and many engineering firms are considering the taking up of its manufacture in one of its forms, either reaction, impulse or a combination of the two. Many works are putting in very expensive plants for their production, and as I have had considerable to do with their manufacture in sizes varying from 100 to 5500 kilowatts, I will describe a few methods and tools used to produce some turbine parts both quickly and cheaply. The following descriptions apply to the Parsons type of machine.

In machining the cylinder the only special tool is the boring rig. This consists of ordinary bars about 4 inches in diameter and long enough to take in the full length of the cylinder, and leave enough to couple up to the driving mechanism at one end and project into the bearing at the other. One of these bars will do for a number of sizes and will require cast-iron bushings to act as guides turned up to a fit just free enough to allow the bar to run inside and be a perfect fit in the gland hole. Some long ones will also be required to fit the bar and be a perfect fit in the bearings in order to bore the cylinder from its own bearings.

After the two main joints of the cylinder have been planed, fitted and the sections bolted together, mark out the bearing sockets and bore to finish size for the bearings, then fit the bearings. Now enter a bar with its liners into the bearings and bore the glands to finished size, lift off the upper half of the cylinder, withdraw the bar and put on the boring heads. There should be one for each pronounced increase in diameter of the cylinder. They should work away from the smallest diameter.

The cylinder should be bored to within 1/16 of its finished size, then the boring rig should be taken out, the glands and ports should be blank-flanged, and steam at from 8 to 10 pounds pressure kept on it for 48 hours. Thus any set or distortion which would occur from expansion will now take place. After this heating the feet should be tested to see if any twist has occurred If so, they should have a very light cut taken to true them. Then the boring bar should be set as before and the finished cuts taken. Any twist which may occur in the bearing housings will make no difference, if the turbine bearings have spherical seats.

The rotor will offer no difficulty in machining, as it may be first roughed out nearly to size, and then correctly bored to receive the shaft. The shaft is then shrunk in, and it is then completely grooved and finished ready for blading.

Blading and packing can be purchased rolled to the correct section, and it is of course a simple matter to cut it to length. Great care should be taken with the dummy blades that they do not groove or tear when first starting up. They should be set a few thousandths clear and the machine brought up to working heat. Then it may be turned around by steam very slowly and the dummies eased off, until they just clear.

The joint between the top and bottom halves of the cylinder should not be scraped, but filed roughly with a second-cut file, and the joint made with graphite paste and boiled oil.

Great care should be taken with the balancing of the wheel. This should be done on a solid pair of ways, and not rushed, after which the spindle should be put in and the whole run at full speed before coupling to the generator. Before running in, however, note the position of the balance weights on the shaft at each end; then, if necessary, a careful running balance may be made by means of marking the shaft with lead when running and placing a trial weight, which will be directly opposite the hardest marked place in a very high-speed machine. In a moderate-speed machine this hardest marked place will lead the lighter part by about 30 to 40 degrees. When the balancing is once properly done it will not alter unless a strip occurs.

The generator should receive the same treatment, but this will require rebalancing after a little running, as in heating the coils are bound to move a little, which of course will change the balance.

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Proposed New Patent Law in Great Britain

The bill now under consideration in England to amend the law relating to patents and designs, has brought out some interesting editorial discussion in the columns of several of our British contemporaries. This bill has as one of its most important features a section dealing with the revocation of patents unworked in Great Britain. This provides that, at any time not less than three years after the grant of a patent, any person interested may apply to the comptroller for the revocation of the patent on the ground that the patented article is manufactured exclusively or mainly outside the United Kingdom. Then, unless the patentee can prove that the article in question is manufactured to an adequate extent in the United Kingdom, or gives satisfactory reasons why it is not so manufactured there, the comptroller may issue an order revoking the patent, provided that such order is not at variance with any treaty or arrangement with the country of which the patentee is a citizen. Any decision, however, of the comptroller is to be subject to appeal to the court.

The *Engineer*, of London, while advocating generally the passage of the bill, points out certain features which it believes could be modified to advantage. Thus, in connection with the section just referred to, it says:

"Passing by the enormous difficulties associated with such an indefinite expression as 'adequate extent,' we may notice that such a clause as this might act very hardly on the inventor. It might well be the practice of powerful and unscrupulous firms to refuse to consider an invention until the three years had expired, when, under the threat, shall we say, of getting the patent revoked altogether, they would be able to induce many an inventor to accept their very disadvantageous terms. That is plainly the very opposite of the object in view. The proposal of the associated chambers of commerce was, as far as its terms are known, far simpler and without this drawback. It specified, we believe, no limiting time. All it said was that *if* an article was manufactured abroad, then it was, if the patent was to be kept in force, imperative that it should be manufactured in this country also. The point is that it made the use of the process or manufacture of the invention abroad the hinge upon which revocation turned. In a great number of cases, we believe, a clause of that kind would act perfectly well, but unfortunately a difficulty arises in other instances. For example, where a patented article is in question there could be no difficulty, but should a patented process be employed some trouble might be found, because it is by no means easy to produce satisfactory evidence that a particular process is in use if the user does not wish it to be known. To take a case: A foreign firm holds a British patent for a process of hardening armor plate. It uses the process abroad, and sends the plates to this country. Some interested person seeks revocation of the patent, on the ground that it is worked abroad, and not here. He would have to prove that it was actually worked abroad, and to collect evidence of that fact would be extremely costly, if not impossible. It must be remembered that even in the case where a foreigner's evidence is required for a purpose not affecting that foreign country, we are powerless to compel this evidence to be given. The court can only issue 'letters of request,' and experience has shown that such letters are rarely fruitful. How much less likely is it, then, that where such evidence is actually prejudicial to the foreign country, it would be given? This is a very real difficulty in the way of a simple proposal, and we point it out, not because we deem it insurmountable, but because all sides must be considered. It introduces, too, an alternative which has been proposed, and which has many good points. It is this: After the lapse of two years from the granting of the patent, if the patentee or his licensee are not working the invention, than anyone else may employ it. At the end, however, of another two years, or any succeeding biennial period, if the patentee or his agents have begun to manufacture, they may bring the matter before the comptroller or the courts, who shall decide what is a fair royalty to be paid by the first firm for the past and future use of the patent. Such a plan would immediately remove the offense of foreign-worked patents, and it would probably operate to the benefit of the poor inventor, since his patent would be valuable through the whole term of its existence."

In another interesting editorial on this subject which appears in *Engineering*, of London, and which takes up the various important features of the proposed new law, the clause relating to the revocation of unworked patents is discussed as follows:

"This is a matter requiring careful consideration and cautious treatment. Some authorities incline to the opinion that an inventor should not enjoy an exclusive right to his invention in this realm unless it be actually worked here. But an enactment to that effect would, in practice, deprive of all reward for their ingenuity the large proportion of inventors whose ability to get their inventions worked absolutely depends upon their succeeding in securing the coöperation of capitalists. Many valuable improvements have emanated from inventors of limited means, and it would be highly inexpedient and grossly unjust to treat an inventor's lack of means as a reason for robbing him of his invention.

"On the other hand, it is clearly in the

interest of the community to promote coöperation of inventors and capitalists, and it is the protection afforded to the former by the patent laws which enables such coöperation to be brought about. The circumstance that a patented article is being manufactured exclusively or mainly outside the United Kingdom ought not to be treated as a ground for revocation of the British patent, unless the article is being imported into this country. The aim of our patent laws is to promote our manufacturing industries, and this will not be effected by unduly harassing inventors, or by rendering their patent rights needlessly uncertain. The abuse to be guarded against is the use of the exclusive privileges conferred by letters patent to secure a monopoly here for articles of foreign manufacture. The most effectual way of attaining the end in view would probably be to provide that a patentee might, on a *prima facie* case being made out at any time after three years, be called upon to prove to the satisfaction of the comptroller (and of the court, in case of appeal) either that the patented article is not being imported into this realm to any appreciable extent; or, in the contrary case, that it is being manufactured here to at least an equal extent. That would apply all round, whether the patentee be a British subject or an alien. And it would be additional to the adequate protection of our manufacturing industries which a simple and economical compulsory licensing system would afford."

The same journal refers as follows to the section dealing with patents for chemical inventions:

"It is proposed that, in the case of an application for a patent for a chemical invention, the provisional and complete specifications shall be accompanied by such specimens or samples as may be prescribed. In many cases this will be tantamount to refusal of provisional protection and letters patent for chemical inventions. Not only so, but the provision strikes at the very root of the system of granting provisional protection. The object of such protection is to enable the inventor to perfect his invention by experiments which, although open and known, will not constitute such a use or publication as will invalidate the letters patent to be afterward granted upon his application; thus he is supposed to be enabled, as the result of experience, to adequately describe in his complete specification the best manner of performing his invention. But the suggested provision would force the inventor to run the risk of practising his invention while still unprotected. This would place the British inventor at a disadvantage, because an inventor applying for a patent in some country belonging to the international union, in which deposit of specimens or samples is not insisted upon, might secure a date of priority, thus obtaining protection before entering upon the production of the specimens or samples to be lodged in the United Kingdom, with a subsequent application for patent, which would date back, under the convention, to the date of the foreign application. In many cases the British inventor of limited means would be shut out altogether, and thus our patent law would have the effect of discouraging, instead of encouraging, the production of new and useful inventions, especially those of British origin."

It would seem upon careful perusal of the text of this bill and from the different points elucidated by our contemporaries from whom we have quoted above that the proposed measure if enacted into law by Parliament is likely to be far-reaching in its effect upon inventors and manufacturers, whether British subjects or citizens of other countries. It is not feasible at this time to present the other important provisions of the bill, though these may be referred to later. So far, at least, as the compulsory working of patents is concerned, this provision if incorporated in the new law would appear to place future English patents issued to foreigners upon somewhat the same basis as those granted by Germany, Canada and certain other countries where patents on articles and processes issued to individuals in other countries must be worked in order to be valid.

The Middle American

Those who like to follow up industrial matters and problems will doubtless find of considerable interest Joseph Jacobs' article on "The Middle American," published in the current issue of the *American Magazine*.

Mr. Jacobs states that there are approximately 15,000,000 white families in our country, and if the heads of households (assuming them to be males over 15 years of age) were alined in order of age from 15 to 94 years, number 7,500,001 would be "the middle American" in age, and on January 1, 1905, would have been a little under 33.

In preparing this article on what he considers the "typical American," whom he designates as Samuel Thwaites Raggers, Mr. Jacobs quite naturally found great difficulty in determining the mean American income, owing to the fact that while details may be obtained of the earnings of those classed as wage-earners, there is in this country no method of grouping professional and mercantile classes in order of income. However, after estimating the number of households in America at 15,000,000, as noted, and eliminating in the neighborhood of 1¾ millions of merchants, hotel-keepers, and certain other classes with annual incomes of from $1000 to $100,000, he arrived at the conclusion that there are about 7,000,000 families of wage-earners whose median income is $436, and 5,000,000 farmers whose medium farm of about 60 acres would produce $350; and from these data he places the average income of his middle American at $490.95.

Raggers' family consists of a wife and three children, and occupies a five-room frame house in the Middle West. The head of the house earns $10 per week in a local mill, and loses for various causes about four weeks' time per year, bringing his earnings down to the total above given, of $490.95 per annum. He averages 52 hours' work per week, and receives between 18 and 19 cents per hour. Of his earnings of $10 weekly he spends $9.44, nearly 1/5 of which is paid for rent, while 2/5 goes for food. If Mr. Jacobs' figures are to be relied upon, Raggers can hardly be considered a spendthrift, as the weekly outlay for such things as newspapers and magazines is but 12 cents, for insurance 23 cents, for amusements 6 cents, and so on.

The writer goes into considerable detail, more or less interesting, pertaining to Raggers' personal characteristics, habits at home and abroad, church connections, his affiliations with benevolent orders, etc. He says that he goes on one excursion a year, reads little aside from his newspaper, never misses a State or Presidential election; and looks forward to earning on the average $15 per week as his highest ideal in this respect.

In conclusion Mr. Jacobs says of his middle American: "There are as many above him as below him, and especially as many below him as above him. What must be the condition of the under half if the above facts and figures truly depict the life of Sam Raggers, the middle American, the midmost man in the nation's ranks?"

Boiler Makers' Convention

The International Railway Master Boiler Makers and the Master Steam Boiler Makers' Associations will convene in joint session in Cleveland, Ohio, at the Hollenden Hotel, May 21, 1907.

All boiler foremen and assistant foremen, and others who are actively interested in boiler designing, construction and maintaining are cordially invited to participate in the discussions of the meeting.

It is expected that there will be from 500 to 600 members present and that a permanent consolidation of the two organizations will be effected at this time.

The exports of Japan are now exceeding the imports and have done so for several months. During the early months of last year the reverse was true, leading to an excess of imports for the year of $3,500,000.

Solving a Problem without Mathematics?

By Cope Knowle

A number of years ago, a special apprentice in a certain large foundry was called upon by the head of the concern to solve the following problem:

A 36-inch cast-iron water pipe was to be used as a storm-sewer outlet. To prevent flood water backing up into the sewer a cast-iron flap valve or lid had been ordered. This lid was to be so balanced that a very slight water pressure behind it would open it and yet it must close immediately upon the relieving of the pressure.

The city engineer had sent a blue-print showing the angle, about 60 degrees, at which he wanted the pipe cut, the design of the lid, an ellipse with heavy hinge lugs and ribs, the design of the counter weight and the arm supporting it. The angle that the arm would make with the face of the lid, its length and the amount of counter weight were, however, omitted. The engineer was asked for this but his only reply was a smile and the remark that the foundry would have to figure that out. Figuring was tried, but so many variables were found that the conclusion was reached that the engineer was dodging.

Putting It up to Harry

Various plans to find the angle were suggested by the different foremen, none of which offered any reasonably cheap solution. The lid weighed about five or six hundred pounds and the arm was shown as a ¾x4-inch bar of wrought iron forged to shape. The danger of cutting the bar short, the difficulty of handling it uncut and the greater difficulty of guessing at the angle it should be bent to, together with the weight and unwieldy shape of the lid precluded the idea of experiments. Nevertheless, experiment was about all that seemed to be left, when someone suggested that Harry (the special apprentice) might be able to figure it out. Anyway, it would be a good chance for him to show what his college training was good for. Consequently Harry drew the job and he was called from the cupola room where he was heaving coke and pig iron.

Harry was "treed," but it was almost quitting time when he was called so he used that as an excuse and put off the trouble till morning. That night he did some thinking along lines that he had not used for a year or two and, as if by inspiration (it was really his class-room training he thought of the *df's, dx's,* and *dz's* of his mechanics.

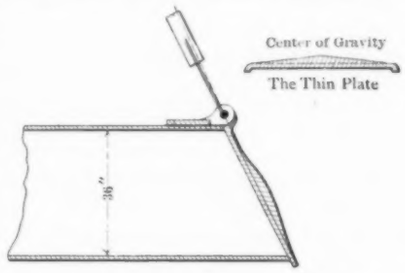
How He Went About It

This is what he did the next day, despite the jokes and scorn of his shopmates:

Taking the *wooden pattern* of the lid and, setting up a straight edge on a planer platen, he *balanced* the pattern on it; using the short diameter of the ellipse. The weight of the hinge pin he disregarded, and as they were loose on the pattern he left them off during the balancing. Likewise the part of the counter-weight arm on the lid was disregarded as an equal part would be above the hinge center.

He next took the pattern to the pattern shop and had thin plate or cross section of the pattern made corresponding to the axis he had found. Then he balanced his thin plate on the point of a scribing awl. This gave him the center of gravity of the lid.

The next move was to lay off the center of the hinge pin and the center of gravity (for convenience this was done in actual size, although it could have been done to scale). The prolongation of the line connecting these two centers gave him the center line on the counter-weight arm.



BALANCING THE SELF-CLOSING COVER

The angle this line made with a line through the hinge center parallel to the face of the lid gave the required angle A few minutes time made the templet for the blacksmith.

The length of the arm and the amount of counter weight were then readily determined mathematically.

Dissappointed Doubters

When the time came to assemble the job, the scoffers were on hand with their ready laugh but they were disappointed. The lid balanced to perfection and all that was needed to open it was the pressure from the little finger of the smallest "kid" in the shop. The foreman of the pattern shop, while he lent ready assistance, was so skeptical of the result that he had ordered two or three additional weights but they were unnecessary.

As can be readily seen the job was done without any reference as far as the shop men could see, to mathematics. There were no abstruse calculations and, with the exception of the simple calculations for the counter weight and its arm, there were no figures put on paper.

Why He Used the Pattern

Harry's reasons for using the pattern instead of the casting were two-fold: The pattern was easily moved and the casting was not. The center of gravity of the pattern would also be the center of gravity of the casting, or near enough for all practical purposes, and that was what he needed.

As this incident occurred at least ten years ago the writer has only been able to give general results with the idea of illustrating the methods. It was recalled to the writer's memory recently when he saw the labored efforts that a good mechanic was putting forth to solve a similar problem.

To the user of formulas there is no difficulty for him to apply their principles *provided he thoroughly understands them.* If he does not understand the principles on which they are founded he will find that their use complicates rather than facilitates.

If our average graduate will learn the application of the principles he has been taught he will avoid many a pitfall dug for him by his jovial shopmates.

Machine-steel Collets

By E. V.

Several years ago I had charge of the tool rooms and battery of hand and automatic screw machines in a factory making bicycle cones and nuts, and there was continual trouble caused by the breaking of the spring collets in the screw-machine chucks.

The machines were all first-class, but the collets, which were all made of tool steel, and carefully hardened and drawn by the different makers, seemed to crystallize and break with equal impartiality, and the collets we made ourselves fared no better, so at last, after repeated trials, I determined to try a few made from cold-rolled machine steel and case-hardened. I turned up four exactly the same size in every way as the original ones of tool steel and case-hardened them with cyanide in an ordinary forge. They were put in the nut machine, where they would get the hardest usage, and as a result of their staying qualities, I replaced every collet in the shop with those made of machine steel, as fast as the tool-steel ones gave out.

Three of the first machine-steel collets I made were in continual use for over two years, when one was broken accidentally, and from the time I began using machine steel, we did not average to break more than one collet a year for each machine, while the wearing qualities were far beyond my fondest hope.

All the new small screw machines that I have seen, whether hand or automatic, have had tool-steel collets, and I write this in the hope that it may help some toolmaker who is bothered to death with crystallized collets, just as I was.

Personal

E. P. Leadbetter has been appointed manager of the Pittsburg office of the Buffalo Forge Company.

Prof. C. R. Richards, head of the Department of Mechanical Engineering, has been elected dean of engineering at the University of Nebraska.

E. C. Angell has resigned his position as general superintendent of the Jones Speedometer to accept the general management of the Winchester Speedometer Company.

F. F. Nickel, formerly chief designer for Henry R. Worthington, has opened an office as consulting engineer at 150 Nassau street, New York City. His long experience will no doubt well qualify him for his duties.

Obituary

John A. Keller, general manager of the coal-operating department of the Colorado Fuel and Steam Company died at Trinidad April 12.

Thomas Venners, retired ironmaster, and at one time an associate of Henry Bessemer, died April 18 in Brooklyn, aged 84 years. Mr. Venners was a prominent figure in the iron and steel trade for a period of over 30 years, and invented many processes in connection with his industry.

Business Items

The New York office of Wells Bros. Company, manufacturer of screw-cutting tools and machinery, has been moved from 56 Reade street to 126 Chambers street.

Marshall & Huschart Machinery Company, machinery merchants, Chicago, Ill., announce that they have opened offices at 908-910 North Second street, St. Louis, Mo.

The Grant Manufacturing and Machine Company, Bridgeport, Conn., has purchased the revolution counter business from Tabor Manufacturing Company, Philadelphia, Penn.

The United States Government has awarded to the Westinghouse Companies a contract for the complete electrical equipment of the power station now being erected in connection with the new Congressional buildings in Washington, D. C.

Hill, Clarke & Company, New York City, have moved into the West building, which is located on West street and runs from Cedar to Albany streets. They will have a large show room, connected with their new offices, and will carry in stock a number of machines.

Electric power for the Jamestown Exposition will be furnished by steam turbines located in the power house of the Norfolk Railway and Light Company about seven miles from the exposition grounds. These turbines, as well as the complete electrical equipment, will be supplied by the General Electric Company.

Trade Catalogs

Sprague Electric Co., 527-531 West Thirty-fourth street, New York. Catalog of electric fans. Illustrated, 34 pages, 7x9½ inches, paper.

Buffalo Forge Co., Buffalo, N. Y. Leaflet illustrating and describing improved types of dust separators, planing mill and volume exhausters.

American Locomotive Co., New York. Catalog of ten-wheel type locomotives weighing more than 150,000 pounds. Illustrated, 72 pages, 6x9 inches, paper.

Dodge & Day, Philadelphia, Pa. Pamphlet No. 16, entitled "Methods and Work of an Engineering Organization." Illustrated, 8 pages, 9x12 inches, paper.

Manufacturing Equipment and Engineering Co., 209 Washington street, Boston, Mass. Catalog of metal shop and factory equipment and specialties. Illustrated, 3½x7½ inches, paper.

Ashcroft Manufacturing Co., 85 Liberty St., New York. Catalog of gages, indicators, counters, planimeters, pantagraphs, stocks and dies, ratchets, etc. Illustrated, 135 pages, 6x9½ inches, cloth.

Manufacturers

The Saginaw (Mich.) Wheelbarrow Company will enlarge its plant.

The Oneida (N. Y.) Steel Pulley Company will build an addition to its plant.

The Utah Plow Company, Ogden, Utah, will erect a plant near Independence, Mo.

The Milwaukee (Wis.) Steel Foundry Company will erect a new plant at West Allis.

The Pilling Air Engine Company, Detroit, Mich., will double the capacity of its plant.

The town of Dora, Ala., will build an electric-lighting plant at a cost of about $10,000.

The Heald Machine Company, Worcester, Mass., will build an addition to cost about $15,000.

Wayman & Murphy, carriage manufacturers, Chicago, Ill., will build a new $45,000 factory.

The Narragansett Machine Company is building an addition to its plant in Pawtucket, R. I.

The Fred Rueping Leather Company, Fond du Lac, Wis., will establish a plant in Milwaukee, Wis.

S. L. Allan & Co., Philadelphia, Pa., agricultural implements, are erecting a new $70,000 plant.

The Albert Russell & Son Company, Newburyport, Mass., has completed plans for a new foundry building.

The United States Steel Corporation will establish a steel plant in Duluth, Minn., to cost about $6,000,000.

The Detroit, Jackson & Chicago Electric Railroad is planning to erect a new power house in Chelsea, Mich.

The Snell Manufacturing Company, East Brimfield, Mass., making augers and bits, will build a three-story addition.

Ground has been broken for a $60,000 extension to the emery-wheel works of the Norton Company, Worcester, Mass.

The Providence (R. I.) Gas Burner Company has taken out three building permits for the enlargement of its plant.

The New Departure Company, Bristol, Conn., will erect another addition, wherein it will manufacture its own forgings.

The Maxwell & Fitch Company, Rome, N.Y., manufacturers of gas and gasolene engines, has been reorganized and the plant will be enlarged.

The Washington, Baltimore & Annapolis Electric Railway Company has awarded contract for the construction of new shops at Odenton, Md.

It is said that E. N. Ohl, of Pittsburg, and George L. Pearson, of New Castle, Pa., are back of a project to build a $1,000,000 blast furnace plant in Ohio.

J. F. Dacey & Son, Duluth, Minn., proprietors of the Gogebic Steam Boiler Works, are planning improvements to cost $50,000. A new foundry will be built.

The Pittsburg (Pa.) Automatic Vise and Tool Company will erect a new plant at a cost of $150,000. In addition to this a $100,000 plant will be erected in Germany.

The E. J. Vandreuil Company, Two Rivers, Wis., is erecting a new factory to be equipped with the latest machinery and canning apparatus, and also a brick power-house addition.

The Reading (Pa.) Oil and Gas Engine Company has been organized with a capital of $250,000 and is taking over the business of the Losch Engine Company. A new plant will be built.

The Kanawha Chemical Engine Manufacturing Company, Charlestown, W. Va., capitalized at $100,000, is preparing to erect a plant to cost in the neighborhood of $80,000. Ellis Crawford, president.

The Manufacturers' Foundry Company, Milwaukee, Wis., recently organized with a capital of $200,000, will erect a plant to empoy 200 persons. B. H. Berendsen, W. A. Aschmann and H. Friedschmidt, incorporators.

The Buffalo (N. Y.) Copper Rolling Company, recently organized with $800,000 capital, has purchased site on which a $400,000 plant will be erected. George A. Ray, Robert L. Fryer, Franklin D. Locke, etc., incorporators.

The Crude Oil Power Company, Kansas City, Kas., a new corporation capitalized at $1,000,000, is erecting a plant for the manufacture of steel and malleable-iron castings. This will include two foundry buildings and four machine shops. W. E. Fitzpatrick is president.

The Southern Skein Manufacturing Company, Chattanooga, Tenn., a branch of the Illinois Bolt and Iron Company, has had plans prepared for the construction of its plant, which will consist of a foundry, machine shops and power house.

The Anaconda Copper Mining Company (Foundry Department) Anaconda, Mont., are revising and bringing their catalog files up to date and would be pleased to receive catalogs from manufacturers of machinery, tools and power equipments of all kinds.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Cox Computers, 75 Broad St., New York.

Slide rule taught, 322-150 Nassau, N. Y.

Caliper catalog free. E. G. Smith Co., Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Light fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Special machinery to order, carbon and other molds specialty. O. Anderson, 30 Lawrence St., Newark, N. J.

Wanted—A machine shop to manufacture for the market a high-grade, large-sized machine. Box 795, Canton, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—Machine work for lathes, planers and boring mill in a shop well equipped to handle medium and heavy work. Manufacturer, P. O. Box 217, Dayton, Ohio.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—Second-hand, or new, hand turret lathe of 16-inch swing, back geared, 1¼ to 2¼" hole in spindle. Pollard-Alling Manufacturing Co., 312 East 23d St., New York.

Small automatic machinery for special work, models, jigs, etc., built to order. Satisfaction guaranteed. Novelty Engineering Association, Box 264, Fitchburg, Mass.

Arrange with us to do your manufacturing; we build special machinery, special tools, etc. Lewis Blind Stitch Machine Company, 502 North Commercial St., St. Louis, Mo.

Experimental engineer, now in charge with large corporation, desires to undertake in spare time development of ideas on automatic or other machinery; communication solicited. Box 859, AMERICAN MACHINIST.

A large English firm of machine-tool importers, having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Wanted—A manufacturer to make for the market in both large and toy sizes French's Pyro-motor a heat engine run by the expansion and contraction of metal. Have fine working model. Address W. W. French, Fort Branch, Ind.

Wanted—To buy patent, or manufacture under royalty, any specialty where high-grade grey iron castings constitute 60 per cent. or more of total cost; would also consider New England or Eastern rights to established article. "Founder," care AMER. MACHINIST.

Draftsmen, engineers, learn automobile drafting and designing, including the latest European and American practice; the only field not overcrowded; instruction in class room and by correspondence. The New York School of Automobile Engineers, 146 West 56th street.

Advice; mechanical, practical and technical; tell me your needs. I'll tell you the cost; lowest estimates given on fine tools, dies and presses for sheet metal goods production; have you my books? Jos. V. Woodworth, M. E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

The shops of the Motor Car Specialty Company, at Trenton, N. J., in addition to building speed meters and other high-class speed recording instruments, are open for the manufacture of light high-grade machinery, on contract or royalty basis, either in large or small quantities.

A German gentleman; age 30; civil engineer by profession, is desirous of making arrangements with American manufacturers of electrical or building construction machinery for the sale of their goods in Germany; will be in this country about May 1 for a few weeks. Address Box 896, AMER. MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

An English firm of engineers, manufacturing a machine of world wide demand, selling at about $1500, not being able to cope with the business outside the European continent, wishes to get into communication with a high-class United States firm to buy or work the United States patent; within the next week a representative will be in the States to carry ou the necessary negotiations. Address Box 900, AMERICAN MACHINIST.

A prosperous manufacturer in the States desires to establish a factory in Canada and would deal with a capable young man who can invest $25,000 to $30,000 and take charge of the business; a man familiar with steam engines or steam engine specialties preferred. This is an exceptional opportunity for a young man to establish himself in business, for the proposition is open to full investigation. Address "Opportunity," AMERICAN MACHINIST.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

By competent tool room foreman; 38; familiar with all kinds of die tool and machine work; satisfactory references. Box 894, AMERICAN MACHINIST.

Superintendent wishes to make a change, accustomed to fine and medium heavy interchangeable work; a designer of modern tools, jigs, and special machinery for rapid production. Box 899, AMERICAN MACHINIST.

ILLINOIS

Designing draftsman; American; age 33; technical graduate; 10 years' experience designing machine tools, jigs, fixtures and hoisting engines; references. Box 907, AM. MACH.

MASSACHUSETTS

Blacksmith foreman desires change. Box 800, AMERICAN MACHINIST.

Mechanical superintendent or shop manager now in charge of factory wishes to change; experienced in economical manufacture of light machinery, designer of tools and fixtures for quick and correct work; buyer and factory organizer; age 36. Address Box 903, AMERICAN MACHINIST.

MICHIGAN

Wanted—Position as superintendent or general foreman; experienced; light or medium work; large volume, first class references. Box 862, AMERICAN MACHINIST.

Mechanical engineer traveling in Europe this summer wants to correspond with parties desiring informations, reports, repesentation, etc., of technical nature; has successful experience in this work. Box 889, AMER. MACH.

MISSOURI

Superintendent with record at reducing costs and increasing output can be at liberty June 1; prefer position in Chicago, but would consider proposition in any of the central States. Box 886, AMERICAN MACHINIST.

NEW JERSEY

Graduate of German university wants position; practice in steam turbine work; familiar with all kinds of figuring; any location. Box 870, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman seeks position. Box 895, AMERICAN MACHINIST.

Position as foundry foreman; capable and efficient; best of references. Address Box 884, AMERICAN MACHINIST.

Draftsman, mechanical (25), wishes permanent position in New York or New Jersey; best of reference. Box 902, AM. MACH.

Superintendent; age 37; wide experience on interchangeable work, special machinery and metal specialties; executive ability and excellent manager of men. Address Box 802, AMERICAN MACHINIST.

Draftsman, mechanical, technical graduate; shop experience; designing ability; neat tracer; good detailer; desires position as assistant or draftsman; best references. Box 901, AMERICAN MACHINIST.

Mechanical superintendent, employed, desires to make a change; expert toolmaker, machinist, designer and manufacturing economist; strong executive; salary secondary consideration. Box 795, AMERICAN MACHINIST.

Mechanical superintendent; excellent toolmaker and designer of labor-saving devices, interchangeable parts, machining dies and fixtures; excellent executive and manager; now employed, wishes change, New York or New Jersey. Box 906, AMERICAN MACHINIST.

OHIO

Drop forge superintendent will make a change; all branches; can estimate. Address Box 897, AMERICAN MACHINIST.

Draftsman—Japanese college graduate at Japan, experienced—desires permanent position in machine factory. Box 882, AM. M.

Executive position—Experienced designing light and medium interchangeable machinery and tools for manufacturing same, with some of the best firms in the country; can successfully handle men and introduce modern methods. Box 887, AMERICAN MACHINIST.

Dividend paying manager or superintendent, with technical training as mechanical and electrical engineer, is open to engagement; have just closed successful eight-year record as executive; only position with determined and progressive men considered. Address Box 881, AMERICAN MACHINIST.

Mechanical engineer—with business, executive and organizing abilities, at present in leading position with concern manufacturing successful gas producers and engines—desires to change; can furnish own new designs in above, as well as pumps, compressors and power-transmission machinery; location and line immaterial. Box 890, AMER. MACHINIST.

PENNSYLVANIA

Machine-shop foreman and tool designer; automobiles. Box 892, AMER. MACHINIST.

Machine shop foreman desires position; experienced toolmaker; good executive. Box 876, AMERICAN MACHINIST.

Experienced machine designer, accustomed to original work on fine, automatic and special machinery, desires situation. Address Box 883, AMERICAN MACHINIST.

Wanted — Position as superintendent or shop manager; technical and practical training of 22 years; designed, built and equipped three modern plants; good organizer, systematizer and up to date on modern methods of production. Box 828, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent to take charge of small hardware manufacturing plant, capable of developing into a very large industry, must be a worker, good handler of men and capable of designing tools to produce goods at lowest possible cost; opportunity for ambitious worker. Address, stating salary wanted, to "Canada," AMERICAN MACHINIST.

CONNECTICUT

Wanted—First-class all-around machinist for new and general repair work. The New Machine Co., Danbury, Conn.

Wanted—Semi-technical young mechanics with push as well as ambition; young business with future; give qualifications and salary expected. Box 893, AMERICAN MACHINIST.

Competent machinist and toolmaker to take general charge of tool room in a Connecticut manufacturing concern; must be up-to-date. Apply, giving age, experience and reference, to Box 863, AMERICAN MACHINIST.

Machinist wanted to superintend a machine room of 30 men in manufacturing establishment; must be broad-gauge, manly, a good mechanic, and not over 40 years old; executive ability necessary, with a thorough knowledge of designing and constructing new work as well as repairing; a good salary and permanent job for the right man. Write, stating references to C. D. Morris, R. Wallace & Sons Mfg. Co., Wallingford, Conn.

FLORIDA

Wanted—Boilermakers and machinists experienced on marine work; pay from $3.68 to $2.32 per diem. Apply to Board of Labor Employment, Navy Yard, Pensacola, Fla.

GEORGIA

Wanted—Machinists to work in one of the best shops in Atlanta; good places for good men; open shop. E. Van Winkle Gin & Machine Works, Atlanta, Ga.

ILLINOIS

Wanted—Educated and experienced machine-tool expert in manufacture of gas engines. Ability to handle men to produce best quality goods upon most economical basis. Location near Buffalo. Box 880, AM. MACH.

Wanted — Foreman in the jobbing and special order department of large sheet-metal works; department embraces light and heavy sheet metal of all descriptions; applicant must have large experience and executive ability; German preferred; salary $1500. Address Box 803, AMERICAN MACHINIST.

INDIANA

Wanted—Toolmaker, lathe hands and assemblers; good wages; steady employment; Western Motor Co., Logansport, Ind.

MASSACHUSETTS

Wanted — An experienced sewing machine adjuster and mechanic familiar with overstitch machines. "United," AMER. MACH.

Wanted — A foreman for machine department for a progressing manufacturing concern; good position for right man. Address Box 857, AMERICAN MACHINIST.

Wanted—Tool and die makers accustomed to accurate, complicated work; steady work to thoroughly competent men; wages 40c. per hour, subject to a liberal increase after showing the necessary ability; give references. Address The D. F. Briggs Co., Manufacturing Jewelers, Attleboro, Mass.

Wanted — Young machinist who has had drafting-room experience to be assistant manager of a plant building fine machinery; must be sober, honest, willing to work hard; exceptional chance and interest in business to any one who can prove his ability; give age, experience and references. Box 832, AM. M.

MICHIGAN

Machinists wanted — First-class machine hands and floor hands on heavy work; steady employment assured. Northern Engineering Works, Detroit, Mich.

MINNESOTA

Wanted—A first-class foreman for machine department in large manufacturing plant; must be progressive and a hustler; fine opening for right man; state age, experience and salary expected. Box 885, AMER. MACHINIST.

MISSOURI

Wanted — First-class adjusters accustomed to adding machine and typewriter work. Universal Adding Machine Co., St. Louis.

High-grade tool and die maker wanted to take charge of tool room; steady employment and good wages. Address Irving-Pitt Mfg. Co., Kansas City, Mo.

Draftsman Wanted — Large lead mining company, 65 miles south of St. Louis, Missouri, wants draftsman for mechanical drafting and for making surface and underground maps; must be first-class freehand letterer and neat workman; man with knowledge of plotting and calculating survey field notes preferred; applicants please submit specimens of work and state salary wanted. Box 867, AMERICAN MACHINIST.

NEW JERSEY

Wanted—Mechanical draftsman on small tool and jig work; state age, experience, references and wages expected. Address Box 904, AMERICAN MACHINIST.

Wanted—Tool, die and instrument makers accustomed to accurate complicated work; steady work and good wages to thoroughly competent men; give references. Address Box 438, AMERICAN MACHINIST.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work for good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Several competent mechanical draftsmen wanted with experience on general engineering and construction work; good positions for the right parties assured; none but Americans need apply; state age, salary expected and give references. Box 861, AMER. MACH.

NEW YORK

Wanted—Patternmaker at McEwen Bros., Wellsville, N. Y.

Wanted — Experienced diemaker on drop-forging dies. Box 842, AMER. MACHINIST.

Toolmakers, diemakers and machinists wanted; only first-class. Address or call top floor, 312 East 23d St., New York.

Wanted—Two draftsmen and three tracers on drawings for construction work; state age and salary. Box 877, AMERICAN MACHINIST.

Wanted — Experenced draftsman, toolmakers and machinists; give age, references and wages expected. Remington Arms Company, Ilion, N. Y.

Wanted—Competent operators for milling machines, boring mills, Jones & Lamson and other turret machines on automobile work. The Lozier Motor Co., Plattsburg, N. Y.

An up-to-date man as mechanical superintendent of a mill in Virginia; good position for the right man. Address giving references, salary expected, "O. D. A.," AM. MACH.

Wanted—Several first-class mechanical and electrical draftsmen. Apply, giving age, experience and salary expected, to Engineer in Charge, Drafting Department, General Electric Company, Schenectady, N. Y.

Wanted—Foreman for screw machine department; Brown & Sharpe hand machines and automatic machines, No. 2 and 00; must be thoroughly competent, up to date, and familiar with small accurate work. State wages and references. "S. T.," Box 898, AMERICAN MACHINIST.

Toolmaker to devise methods, tools and fixtures for rapid production, to take charge of a small tool room as working foreman, and to repair machine tools; a permanent position; state experience, references, age and pay expected. Address Green Fuel Economizer Co., Matteawan, N. Y.

OHIO

Wanted—One machinist experienced on a 3-A heavy Brown & Sharpe Universal Milling machine. State wages expected and experience. Leidecker Tool Co., Marietta, O.

PENNSYLVANIA

Wanted — Capable diemakers to work on heavy drop-forge dies; steady work for the proper applicants. Apply, giving references, as well as wages expected. Box 705. AM. M.

Machine-shop foreman wanted to take full charge of all vise work and assembling (small high-grade interchangeable parts in large manufacturing plant; must be able to get the maximum amount of work out at minimum costs. Very good opportunity for the right man. State qualifications, salary expected, and references. Box 891, AMER. MACHINIST.

RHODE ISLAND

We are continually adding to our force experienced toolmakers, machinists and draftsmen on special tools, fixtures and models for light, high-grade machinery. Good wages and steady employment. Apply to Taft-Pierce Mfg. Co., Woonsocket, R. I.

WISCONSIN

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reasons for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI

Instructor in State university in wood working, molding, forge and machine shops, and assistant in mechanical drawing; must be an A-1 machinist and have the equivalent of a trade-school training. Address Box 888, AMERICAN MACHINIST.

For Sale

Test Indicators. H. A. Lowe, Cleveland, O.

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

An established engine lathe business in city of 50,000; reasons to enlarge foundry and limit business to that branch. Address Box 645, Springfield, Ohio.

For Sale—Plant suitable for machine shop and foundry. Splendid location, New York State. Good shipping point. Would take part interest in good manufacturing enterprise. E. W. Fulton, Lowville, N. Y.

For Sale—Cyclopedia of modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address L. N. O., Box 425, Chicago, Ill.

We offer for sale at a sacrifice a standard patented tool which has been on the market for four years and extensively advertised, together with jigs, tools, dies, crude and finished product; orders turned over to the purchaser; best reason for selling. Address P. O. Box 635, Warren, Pa.

For Sale—Established manufacturing plant in northwest Missouri, consisting of well-equipped machine, blacksmith and pattern shop, manufacturing machinery covered by patent; will sell patent with plant or separate; cheap for cash or terms to suit purchaser. Address Box 905, AMER. MACHINIST.

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Belt Lacing Machine

Birdsboro Steel Foundry & Mach. Co., Birdsboro, Pa.

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Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, O.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Yost Mfg. Co., G. M., Mechanicsburg, Pa.

Bolt Heads

Lang Co., G. R., Meadville, Pa.

Bolts, Coupling

Cleveland Cap Screw Co., Cleveland, Ohio.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case-Hardening

Rogers & Hubbard Co., Middletown, Conn.

Books, Technical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., N. W., New York.
Hill Publishing Co., New York.
Piers, Frank, Philadelphia, Pa.
Sames, C. M., Jersey City, N. J.